

North Carolina Retirement System

TSERS Asset - Liability and Investment Strategy Project

Preliminary Results Presentation to IAC

19 April 2016

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Project Purpose

Investment Management Division of the Department of the State Treasurer of North Carolina is undertaking an evaluation of the current and alternative investment strategies for the public retirement systems of the State

The goals are to develop strategies and tactics that will:

- Reasonably ensure earning the actuarially assumed rate of investment return with a desired level of likelihood
- Maintain levels of diversification suitable for a system of its size, given the investment opportunity set available
- Develop and employ suitable risk management measures to limit exposure to market downturns
- Provide the necessary liquidity to meet benefit obligations as they come due

Retirement System Descriptive Information

	TSERS	LGERS	Judicial	Fire & Rescue	National Guard
Valuation Date	12/31/2014	12/31/2014	12/31/2014	12/31/2014	12/31/2014
Assumed Investment Return	7.25%	7.25%	7.25%	7.25%	7.25%
Membership					
• Active	307,313	123,184	566	43,134	5,661
• Pay Status	194,607	60,408	610	12,730	4,421
• Terminated Vested	134,871	55,298	50	153	5,317
• Disabled	7,643				
Payroll Growth					
• Current	0.8%	1.7%	-1.3%	N/A	N/A
• Prior	0.5%	2.3%	0.3%	N/A	N/A
Funded Status (GASB)					
• Actuarial Assets	65,007,030,000	23,047,342,000	538,534,000	386,308,000	110,529,000
• Liabilities	68,692,228,000	23,496,136,000	582,766,000	422,667,000	151,250,000
• Funded Ratio	94.64%	98.09%	92.41%	91.40%	73.08%
Appropriation Determination					
• Normal Cost (NC)	4.37%	**5.70%	15.41%	7,109,033	331,027
• Accrued liability (AL)	5.42%	***7.31%	13.37%	10,718,538	8,276,891
• Death Benefit			0.38%		
Cash flow – prior year					
• Contributions	2,057,963,297	769,285,248	27,157,042	16,648,810	6,393,403
• Benefits	(4,098,385,865)	(1,145,663,992)	(36,101,522)	(27,276,016)	(7,752,511)
• Net cash flow	(2,040,422,568)	(376,378,744)	(8,944,480)	(10,627,206)	(1,359,108)

(**) General and Firefighters

(***) Law Enforcement Officers

Retirement System Descriptive Information

	Registers of Deeds	Legislative Retirement	Death Benefits	Disability Income
Valuation Date	12/31/2014	12/31/2014	12/31/2014	12/31/2014
Assumed Investment Return	3.75%	7.25%	3.75%	3.75%
Membership				
• Active	100	170	307,313 (a)	323,579
• Pay Status	95	300	101,799 (b)	
• Terminated Vested		93	24,005 (c)	
• Disabled			110,891 (d)	6,900
Payroll Growth			0.1% (a)	
• Current	-2.0%	-0.5%	1.3% (b)	1.2%
• Prior	6.2%	2.0%	2.2% (c)	0.9%
			N/A (d)	
Funded Status (GASB)				
• Actuarial Assets	46,994,000	28,456,000	N/A	450,598,573
• Liabilities	23,820,000	23,952,000		503,060,332
• Funded Ratio	197.29%	118.80%		89.6%
Appropriation Determination			(unfunded)/surplus	
• Normal Cost (NC)	931,876	17.14%	72,482,623 (a)	0.15%
• Accrued liability (AL)	(966,865)	0.05%	67,359,021 (b)	
• Death Benefit		*0.61%	36,832,396 (c)	
			(59,135,369) (d)	
Cash flow – prior year				
• Contributions	781,483	226,130	43,889,857	64,520,440
• Benefits	(1,685,664)	(2,564,190)	(61,275,326)	(78,653,910)
• Net cash flow	(904,181)	(2,338,060)	(17,385,469)	(14,133,470)

(*) Disability Benefit

(a) TSERS

(b) LGERS

(c) Separate Insurance Benefit Plan

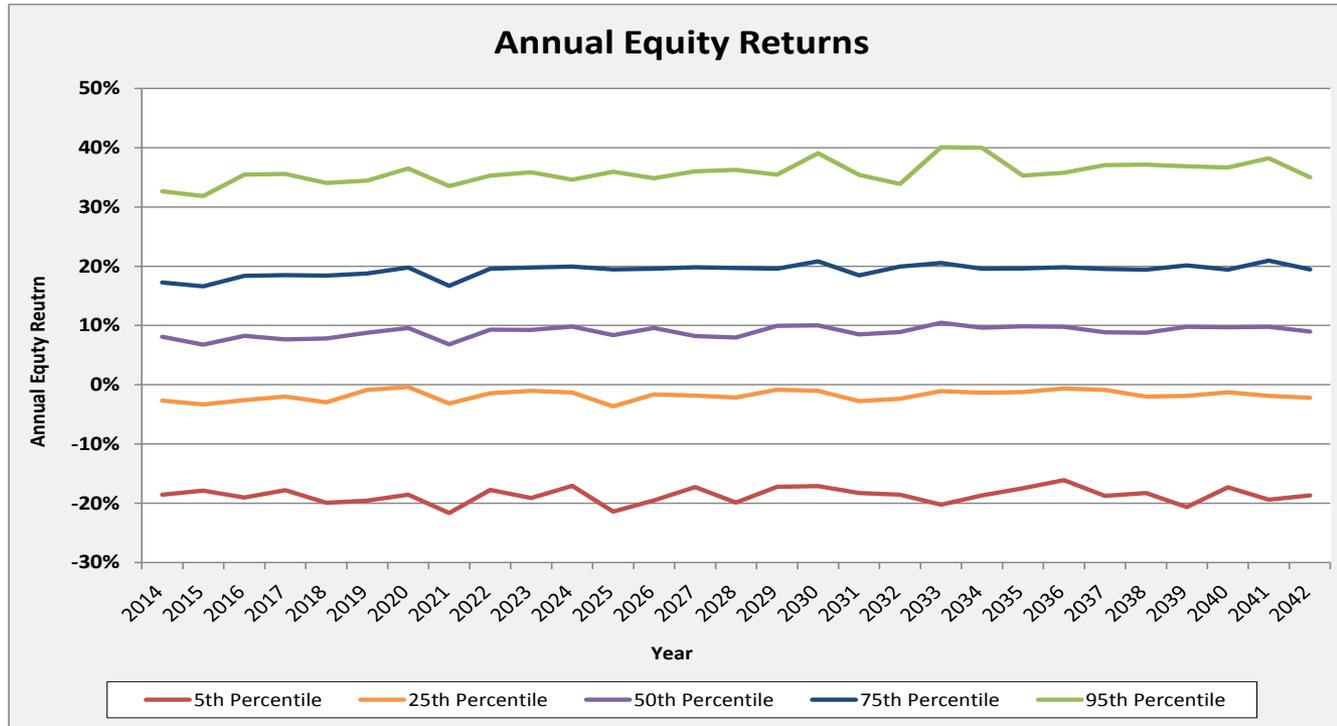
(d) Retiree's Contributory Death Benefit Plan

Employer Contribution Rate Stabilization Policy (ECRSP)

Under ECRSP the TSERS employer contribution rates are equal to the maximum of (1) and (2) but not greater than (3), as described below:

- (1) Current year's calculated ADEC
- (2) Prior year's appropriated contribution rate under the Policy increased by 35 basis points For FYE 2017, assumed to be the FYE 2016 appropriation of 9.15% plus 35 basis points
- (3) Contribution rate determined using a discount rate indexed by the 30-year Treasury Rate as of the actuarial valuation date 30-year Treasury Rate is 2.75% as of December 31, 2014. Maximum contribution rate based on 30-year Treasury Rate is estimated to be 53.48% as of December 31, 2014

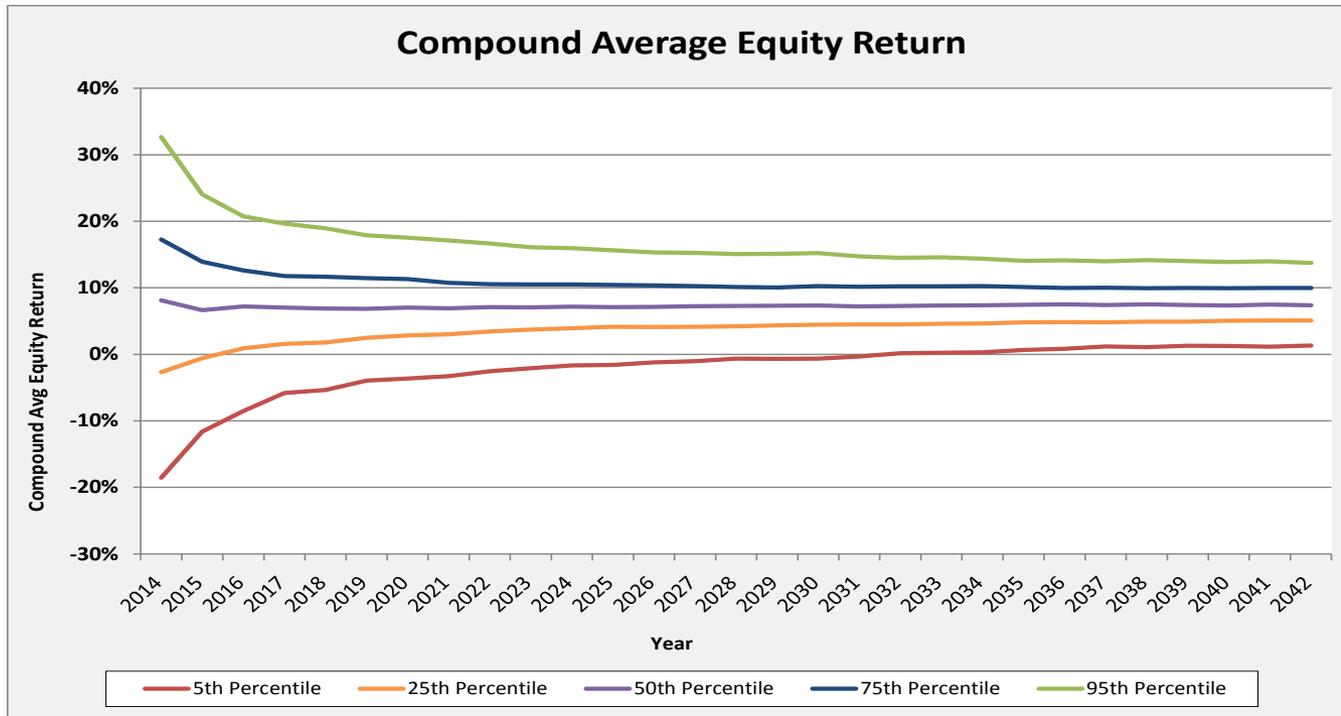
Key Assumptions – Annual Equity Returns



	2014 *	2016	2018	2020	2022	2024	2026	2028	2030	2032	2034	2036	2038	2040	2042
95th percentile	32.6%	35.4%	34.1%	36.5%	35.3%	34.6%	34.9%	36.3%	39.1%	33.9%	40.0%	35.8%	37.2%	36.7%	35.0%
75th percentile	17.3%	18.4%	18.4%	19.8%	19.6%	19.9%	19.6%	19.7%	20.8%	19.9%	19.6%	19.8%	19.4%	19.4%	19.5%
50th percentile	8.1%	8.3%	7.8%	9.6%	9.3%	9.8%	9.6%	8.0%	10.0%	8.9%	9.6%	9.8%	8.8%	9.7%	9.0%
25th percentile	-2.7%	-2.6%	-3.0%	-0.4%	-1.4%	-1.3%	-1.7%	-2.2%	-1.0%	-2.4%	-1.3%	-0.6%	-2.0%	-1.3%	-2.2%
5th percentile	-18.5%	-19.0%	-19.9%	-18.6%	-17.8%	-17.1%	-19.5%	-19.9%	-17.1%	-18.6%	-18.7%	-16.1%	-18.3%	-17.3%	-18.7%

* Model returns not actual results

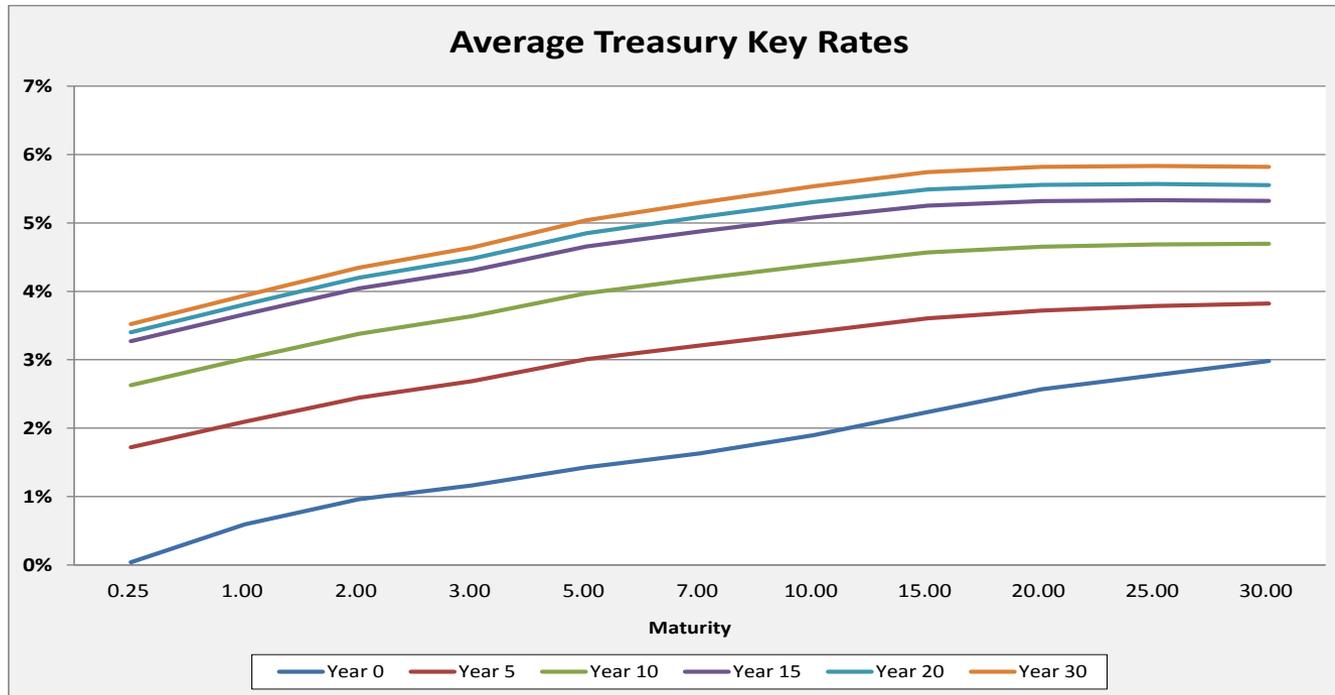
Key Assumptions – Compound Average Equity Returns



	2014*	2016	2018	2020	2022	2024	2026	2028	2030	2032	2034	2036	2038	2040	2042
95th percentile	32.6%	20.8%	19.0%	17.5%	16.7%	16.0%	15.3%	15.1%	15.2%	14.5%	14.4%	14.1%	14.1%	13.9%	13.7%
75th percentile	17.3%	12.6%	11.7%	11.3%	10.6%	10.5%	10.4%	10.1%	10.3%	10.2%	10.2%	10.0%	10.0%	10.0%	10.0%
50th percentile	8.1%	7.2%	6.9%	7.0%	7.1%	7.2%	7.1%	7.3%	7.3%	7.3%	7.4%	7.5%	7.5%	7.3%	7.4%
25th percentile	-2.7%	0.9%	1.8%	2.8%	3.4%	3.9%	4.1%	4.2%	4.4%	4.5%	4.6%	4.8%	4.9%	5.1%	5.1%
5th percentile	-18.5%	-8.5%	-5.4%	-3.6%	-2.6%	-1.7%	-1.2%	-0.6%	-0.6%	0.2%	0.3%	0.8%	1.1%	1.3%	1.3%

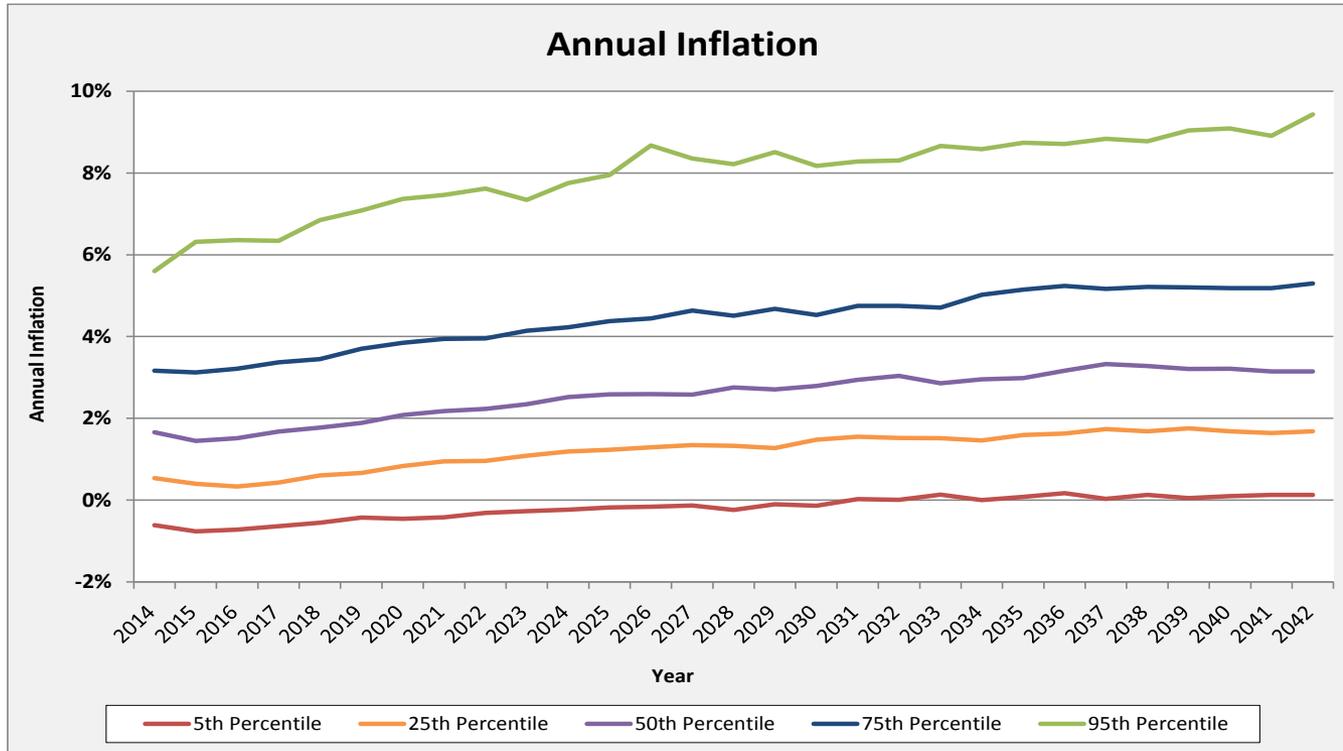
* Model returns not actual results

Key Assumptions – Average Treasury Key Rates



	Maturity										
	0.25	1.00	2.00	3.00	5.00	7.00	10.00	15.00	20.00	25.00	30.00
Year 0	0.04%	0.59%	0.96%	1.16%	1.43%	1.63%	1.90%	2.23%	2.57%	2.78%	2.98%
Year 5	1.72%	2.09%	2.44%	2.69%	3.01%	3.21%	3.41%	3.60%	3.72%	3.78%	3.82%
Year 10	2.63%	3.01%	3.38%	3.64%	3.97%	4.18%	4.39%	4.57%	4.65%	4.69%	4.69%
Year 15	3.27%	3.67%	4.04%	4.31%	4.66%	4.87%	5.08%	5.25%	5.32%	5.33%	5.32%
Year 20	3.40%	3.81%	4.20%	4.48%	4.85%	5.08%	5.31%	5.49%	5.56%	5.57%	5.55%
Year 30	3.52%	3.94%	4.35%	4.64%	5.04%	5.30%	5.54%	5.74%	5.82%	5.83%	5.82%

Key Assumptions – Inflation



	2014	2016	2018	2020	2022	2024	2026	2028	2030	2032	2034	2036	2038	2040	2042
95th percentile	5.6%	6.4%	6.8%	7.4%	7.6%	7.8%	8.7%	8.2%	8.2%	8.3%	8.6%	8.7%	8.8%	9.1%	9.4%
75th percentile	3.2%	3.2%	3.4%	3.8%	4.0%	4.2%	4.4%	4.5%	4.5%	4.7%	5.0%	5.2%	5.2%	5.2%	5.3%
50th percentile	1.7%	1.5%	1.8%	2.1%	2.2%	2.5%	2.6%	2.8%	2.8%	3.0%	3.0%	3.2%	3.3%	3.2%	3.1%
25th percentile	0.5%	0.3%	0.6%	0.8%	1.0%	1.2%	1.3%	1.3%	1.5%	1.5%	1.5%	1.6%	1.7%	1.7%	1.7%
5th percentile	-0.6%	-0.7%	-0.6%	-0.5%	-0.3%	-0.2%	-0.2%	-0.2%	-0.1%	0.0%	0.0%	0.2%	0.1%	0.1%	0.1%

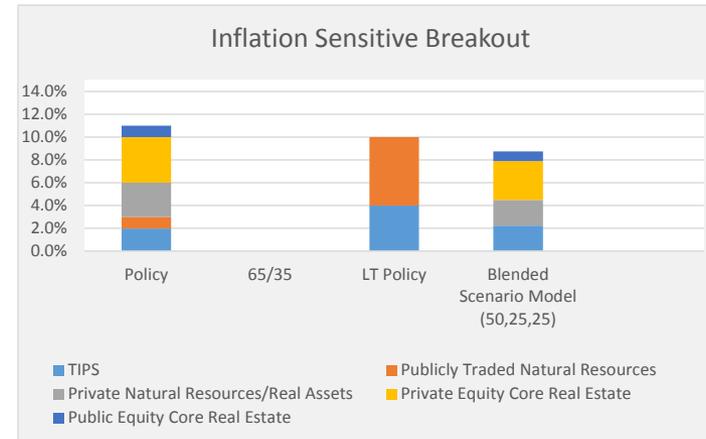
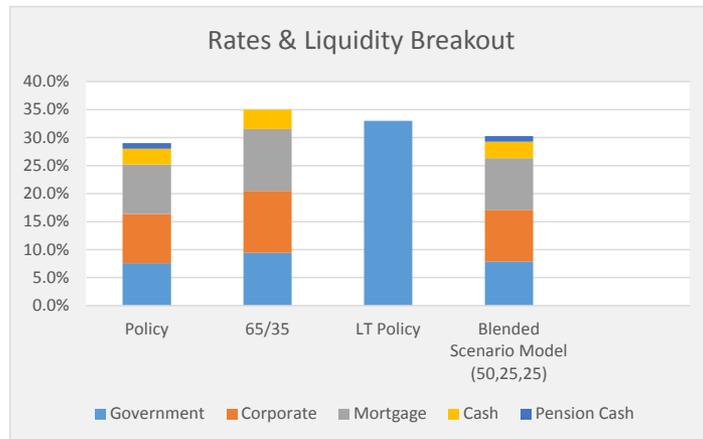
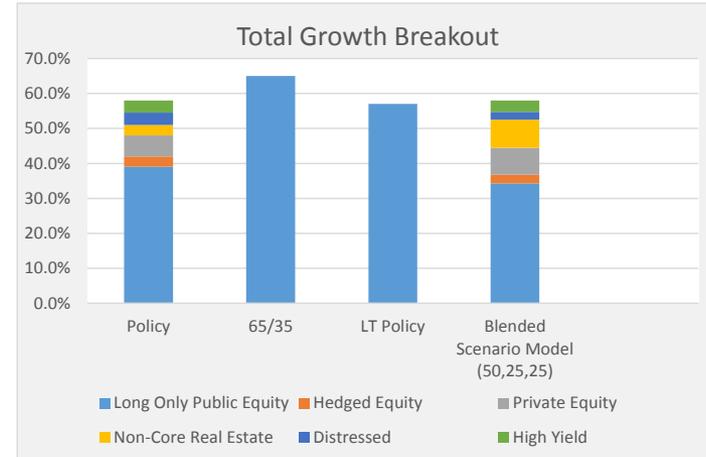
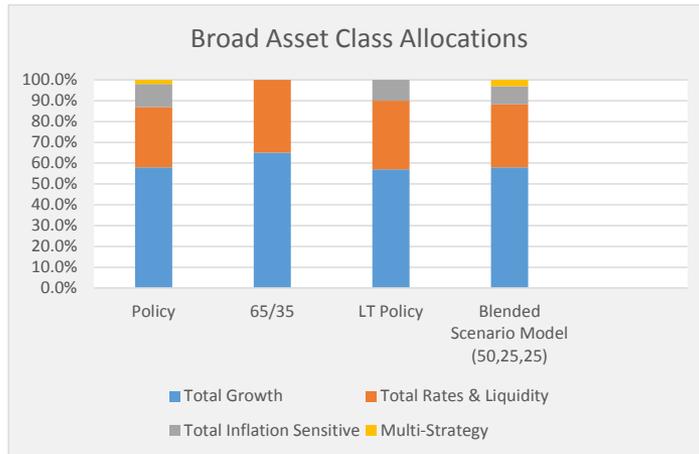
Asset Allocation Policy Alternatives

Statistics	Model Portfolios				Scenario-Based Models		
	Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)	Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation
Allocations							
<i>Long Only Public Equity</i>	39.1%	65.0%	57.0%	34.3%	36.0%	42.0%	23.0%
<i>Hedged Equity</i>	2.9%	0.0%	0.0%	2.5%	3.0%	2.0%	2.0%
<i>Private Equity</i>	6.0%	0.0%	0.0%	7.8%	8.0%	10.0%	5.0%
<i>Non-Core Real Estate</i>	3.0%	0.0%	0.0%	8.0%	8.5%	10.0%	5.0%
<i>Distressed</i>	3.5%	0.0%	0.0%	2.3%	2.0%	1.0%	4.0%
<i>High Yield</i>	3.5%	0.0%	0.0%	3.3%	5.0%	1.0%	2.0%
Total Growth	58.0%	65.0%	57.0%	58.0%	62.5%	66.0%	41.0%
Government	7.6%	9.5%	33.0%	7.9%	6.5%	5.1%	13.5%
Corporate	8.8%	11.0%	0.0%	9.2%	7.6%	6.0%	15.8%
Mortgage	8.8%	11.0%	0.0%	9.2%	7.6%	6.0%	15.8%
Cash	2.8%	3.5%	0.0%	2.9%	2.4%	1.9%	5.0%
Total Rates & Liquidity	29.0%	35.0%	33.0%	30.3%	25.0%	20.0%	51.0%
TIPS	2.0%	0.0%	4.0%	2.3%	2.0%	4.0%	1.0%
Publicly Traded Natural Resources	1.0%	0.0%	6.0%	0.0%	0.0%	0.0%	0.0%
Private Natural Resources/Real Assets	3.0%	0.0%	0.0%	2.3%	2.5%	3.0%	1.0%
Private Equity Core Real Estate	4.0%	0.0%	0.0%	3.4%	3.2%	4.0%	3.2%
Public Equity Core Real Estate	1.0%	0.0%	0.0%	0.9%	0.8%	1.0%	0.8%
Total Inflation Sensitive	11.0%	0.0%	10.0%	8.8%	8.5%	12.0%	6.0%
Multi-Strategy	2.0%	0.0%	0.0%	3.0%	4.0%	2.0%	2.0%
Pension Cash	1.0%	0.0%	0.0%	1.0%	1.0%	1.0%	1.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Statute Constraints Compliance	Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)	Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation
Fixed Income Min (20%)	29.00%	35.00%	33.00%	30.25%	25.00%	20.00%	51.00%
Public Equity Max (65%)	39.06%	65.00%	57.00%	34.25%	36.00%	42.00%	23.00%
Aggregate Alternatives Max (35%)	31.94%	0.00%	10.00%	35.50%	39.00%	38.00%	26.00%
Hedged Equity Max (8.5%)	2.94%	0.00%	0.00%	2.50%	3.00%	2.00%	2.00%
PE + MS Max (8.75%)	8.00%	0.00%	0.00%	10.75%	12.00%	12.00%	7.00%
Real Estate Max (10%)	8.00%	0.00%	0.00%	12.25%	12.50%	15.00%	9.00%
Other Fixed Income (7.5%)	7.00%	0.00%	0.00%	5.50%	5.25%	5.25%	5.25%
Inflation Protection (7.5%)	6.00%	0.00%	10.00%	4.50%	4.50%	7.00%	2.00%

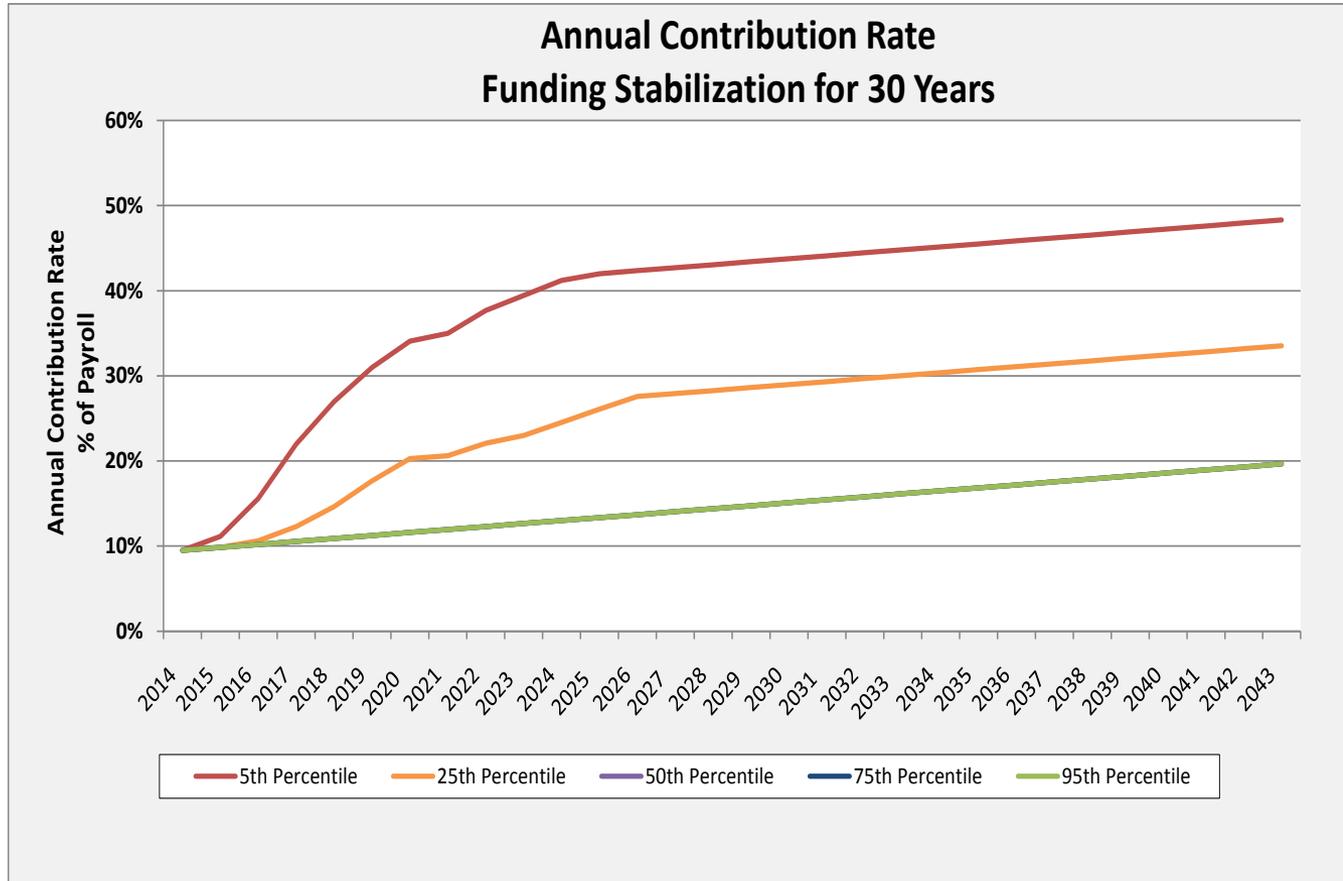
Note: Certain allocations are in excess of asset class limits under current law.

Alternative Strategies

ALM Analysis 2016 - Model Portfolio Analysis - 10 Year Horizon



TSERS Annual Contribution Rate – Policy Portfolio *Reflects ECRSP for 30 Years*



Note: Under ECRSP there is a minimum contribution in effect. This is illustrated using the Policy Portfolio returns in which the minimum contribution rate is in effect for the 50th, 75th and 95th percentile returns and thus equal for the three percentiles. On the graph above, when the contribution rates are equal to each other, the graph lines lay on top of one another, and show up as one line.

TSERS Annual Contribution Rate – Policy Portfolio

Reflects ECRSP for 30 Years

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
95th Percentile Portfolio Return	9.50%	9.85%	10.20%	10.55%	10.90%	11.25%	11.60%	11.95%	12.30%	12.65%
75th Percentile Portfolio Return	9.50%	9.85%	10.20%	10.55%	10.90%	11.25%	11.60%	11.95%	12.30%	12.65%
50th Percentile Portfolio Return	9.50%	9.85%	10.20%	10.55%	10.90%	11.25%	11.60%	11.95%	12.30%	12.65%
25th Percentile Portfolio Return	9.50%	9.85%	10.64%	12.28%	14.62%	17.65%	20.27%	20.62%	22.08%	23.00%
5th Percentile Portfolio Return	9.50%	11.13%	15.58%	21.97%	26.98%	30.97%	34.07%	34.99%	37.69%	39.45%

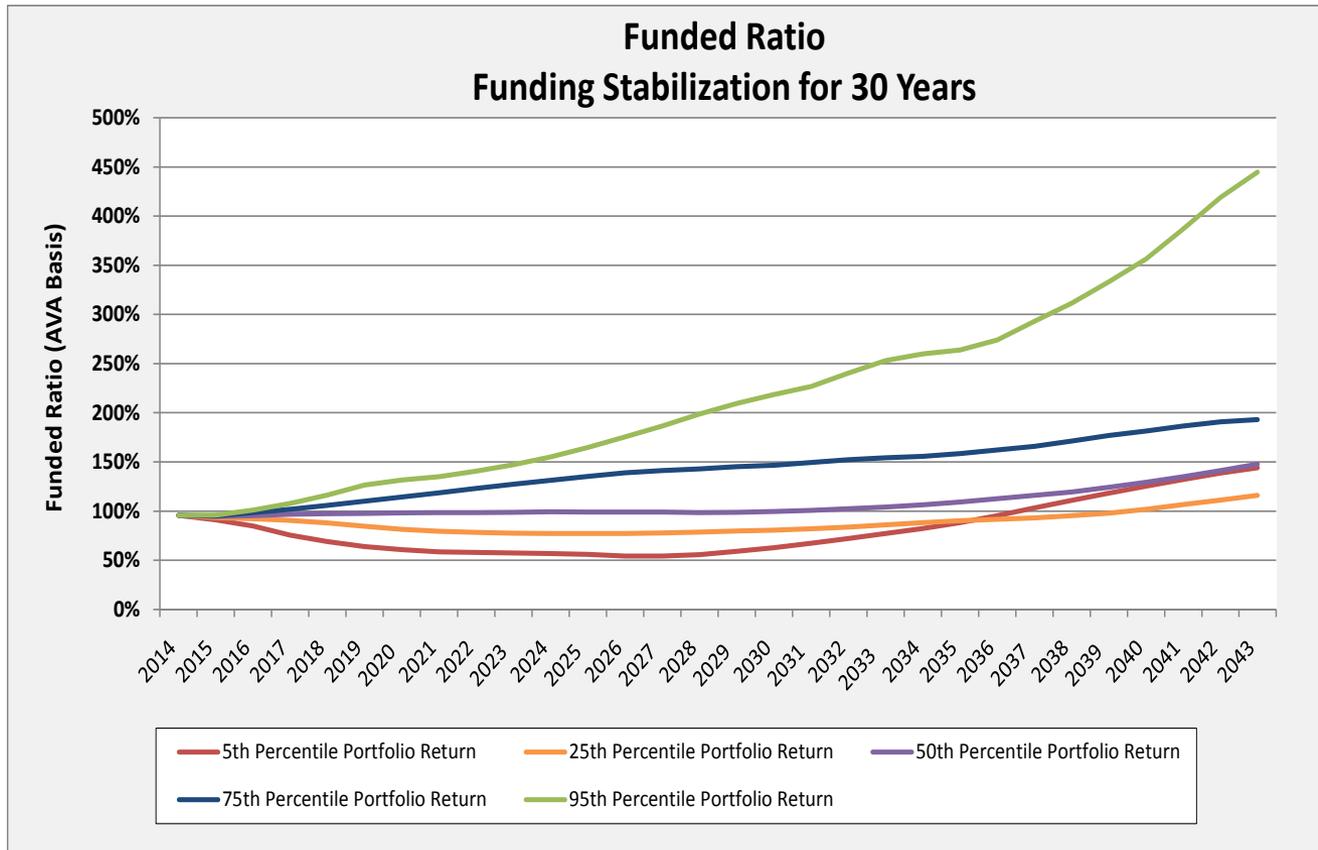
	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
95th Percentile Portfolio Return	13.0%	13.35%	13.70%	14.05%	14.40%	14.75%	15.10%	15.45%	15.80%	16.15%
75th Percentile Portfolio Return	13.0%	13.35%	13.70%	14.05%	14.40%	14.75%	15.10%	15.45%	15.80%	16.15%
50th Percentile Portfolio Return	13.0%	13.35%	13.70%	14.05%	14.40%	14.75%	15.10%	15.45%	15.80%	16.15%
25th Percentile Portfolio Return	24.52%	26.08%	27.58%	27.93%	28.28%	28.63%	28.98%	29.33%	29.68%	30.03%
5th Percentile Portfolio Return	41.20%	42.01%	42.36%	42.71%	43.06%	43.41%	43.76%	44.11%	44.46%	44.81%

	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
95th Percentile Portfolio Return	16.50%	16.85%	17.20%	17.55%	17.90%	18.25%	18.60%	18.95%	19.30%	19.65%
75th Percentile Portfolio Return	16.50%	16.85%	17.20%	17.55%	17.90%	18.25%	18.60%	18.95%	19.30%	19.65%
50th Percentile Portfolio Return	16.50%	16.85%	17.20%	17.55%	17.90%	18.25%	18.60%	18.95%	19.30%	19.65%
25th Percentile Portfolio Return	30.38%	30.73%	31.08%	31.43%	31.78%	32.13%	32.48%	32.83%	33.18%	33.53%
5th Percentile Portfolio Return	45.16%	45.51%	45.86%	46.21%	46.56%	46.91%	47.26%	47.61%	47.96%	48.31%

Note: Under ECRSP there is a minimum contribution rate. For the Policy Portfolio, the minimum contribution rate is in effect for the 50th, 75th and 95th percentile returns throughout the 30-year forecast and are equal to each other.

TSERS Funded Ratio – Policy Portfolio

Reflects ECRSP for 30 Years



TSERS Funded Ratio – Policy Portfolio

Reflects ECRSP for 30 Years

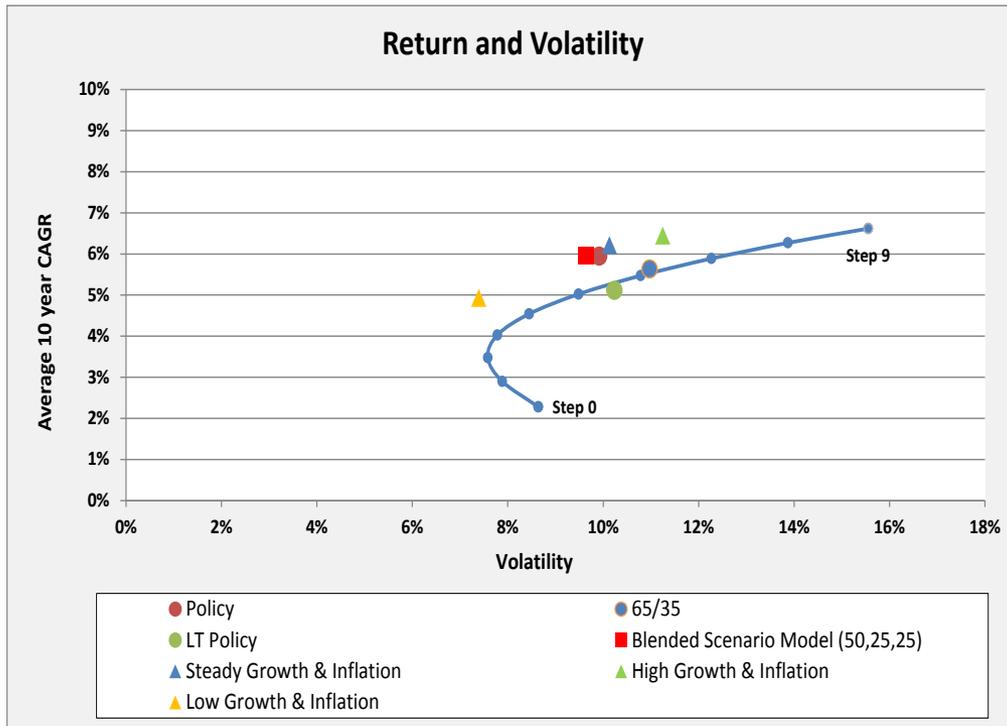
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
95th Percentile Portfolio Return	96%	96%	101%	108%	116%	127%	132%	135%	141%	147%
75th Percentile Portfolio Return	96%	95%	98%	102%	106%	110%	114%	119%	123%	127%
50th Percentile Portfolio Return	96%	94%	95%	97%	97%	98%	98%	98%	98%	99%
25th Percentile Portfolio Return	96%	93%	92%	91%	88%	84%	82%	80%	78%	78%
5th Percentile Portfolio Return	96%	91%	85%	76%	69%	64%	61%	59%	58%	57%

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
95th Percentile Portfolio Return	155%	165%	176%	187%	199%	209%	219%	227%	240%	253%
75th Percentile Portfolio Return	131%	135%	139%	141%	143%	145%	147%	149%	152%	154%
50th Percentile Portfolio Return	99%	99%	99%	99%	99%	99%	100%	101%	102%	104%
25th Percentile Portfolio Return	77%	77%	77%	78%	79%	80%	80%	82%	84%	86%
5th Percentile Portfolio Return	57%	56%	54%	54%	56%	59%	63%	67%	72%	77%

	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
95th Percentile Portfolio Return	260%	264%	274%	293%	311%	333%	356%	387%	419%	445%
75th Percentile Portfolio Return	156%	159%	162%	166%	171%	177%	181%	186%	191%	193%
50th Percentile Portfolio Return	106%	109%	113%	116%	119%	124%	129%	135%	141%	148%
25th Percentile Portfolio Return	88%	90%	92%	93%	95%	98%	102%	107%	111%	116%
5th Percentile Portfolio Return	82%	88%	95%	103%	111%	118%	125%	132%	139%	144%

TSERS Return and Volatility Curve

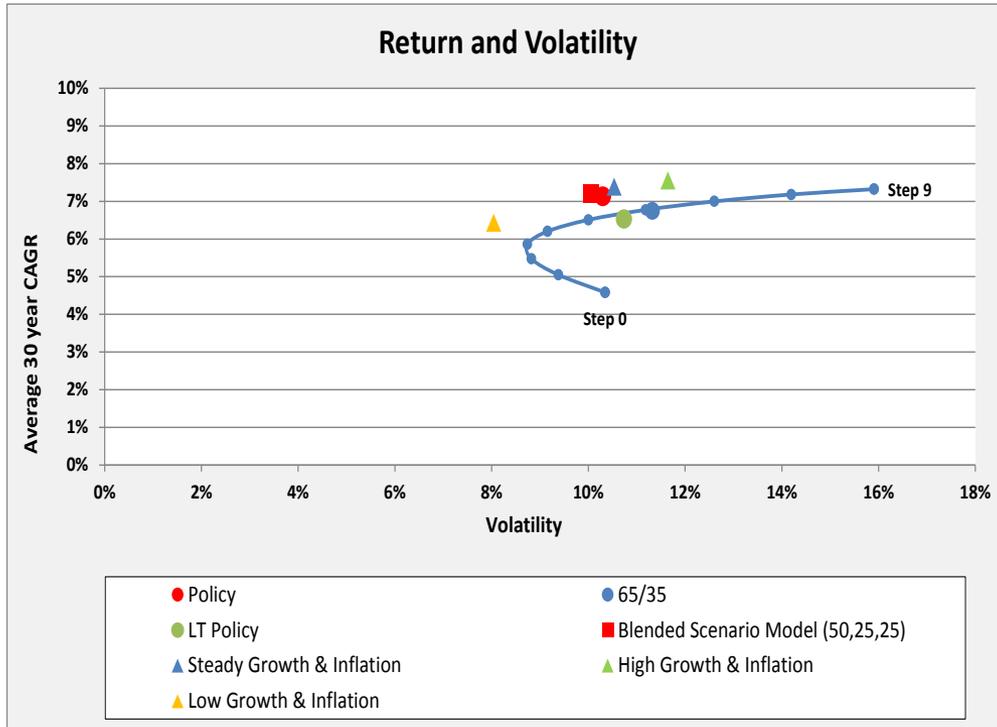
10 Year Horizon



	Average 10 year CAGR	Volatility
Policy	5.9%	9.9%
65/35	5.6%	11.0%
LT Policy	5.1%	10.2%
Blended Scenario Model (50,25,25)	6.0%	9.6%
Steady Growth & Inflation	6.2%	10.1%
High Growth & Inflation	6.4%	11.2%
Low Growth & Inflation	4.9%	7.4%

TSERS Return and Volatility Curve

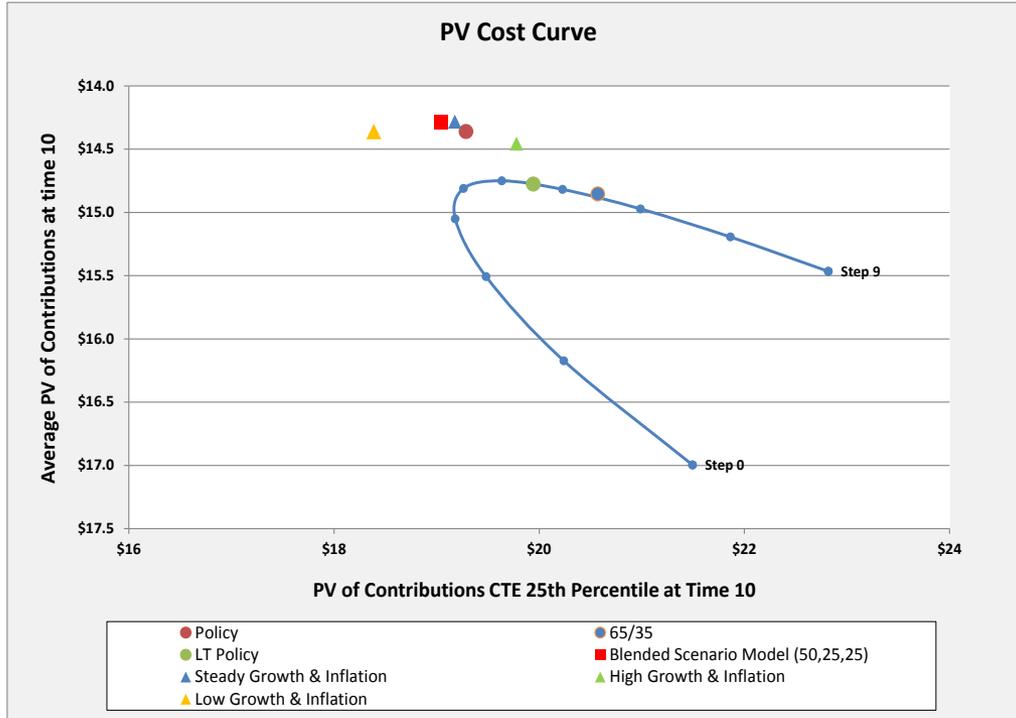
30 Year Horizon



	Average 30 year CAGR	Volatility
Policy	7.1%	10.3%
65/35	6.7%	11.3%
LT Policy	6.5%	10.7%
Blended Scenario Model (50,25,25)	7.2%	10.1%
Steady Growth & Inflation	7.4%	10.5%
High Growth & Inflation	7.6%	11.6%
Low Growth & Inflation	6.4%	8.0%

TSERS Cost Curve

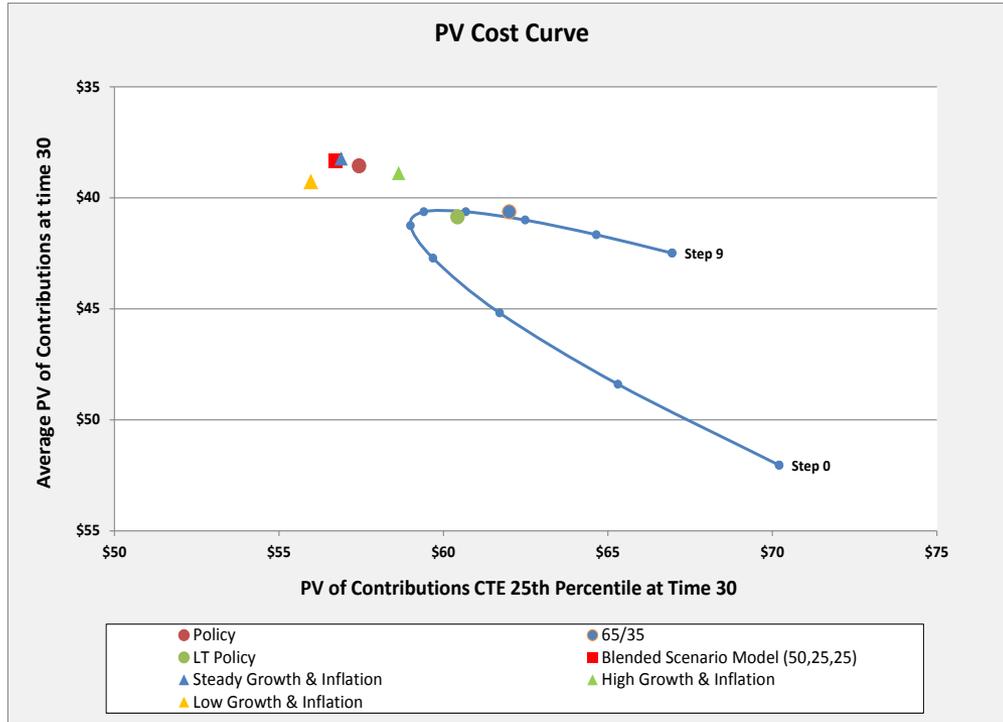
10 Year Horizon



	CTE 25 th Percentile at time 10 (\$Billions)	Average at time 10 (\$Billions)
Policy	19.3	14.4
65/35	20.6	14.9
LT Policy	19.9	14.8
Blended Scenario Model (50,25,25)	19.0	14.3
Steady Growth & Inflation	19.2	14.3
High Growth & Inflation	19.8	14.5
Low Growth & Inflation	18.4	14.4

TSERS Cost Curve

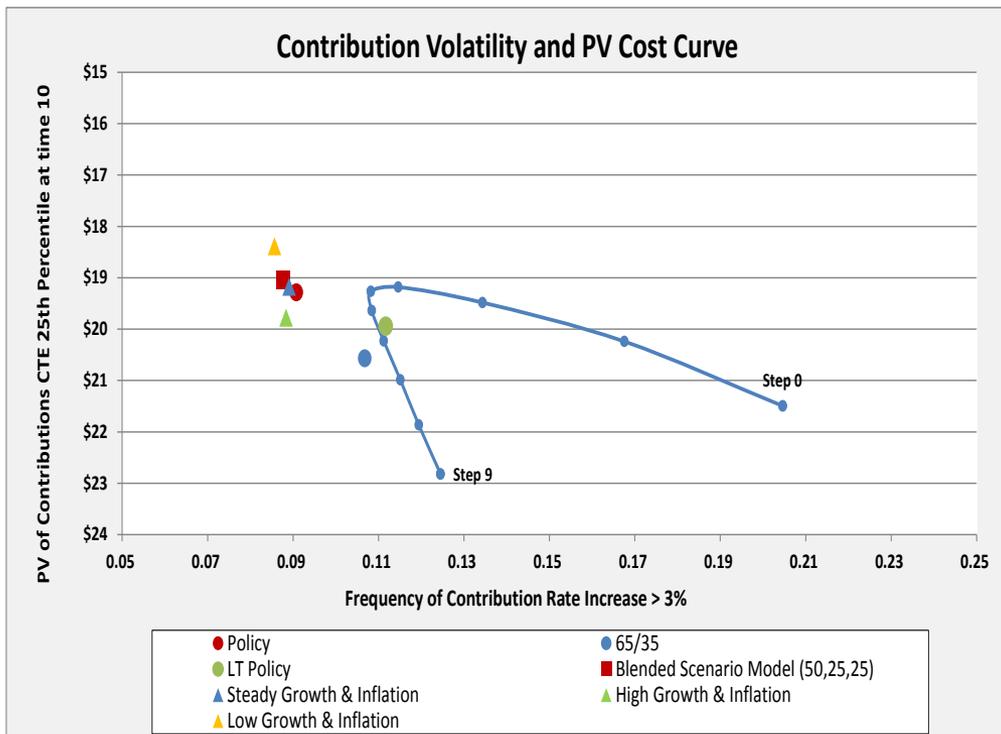
30 Year Horizon



	CTE 25 th Percentile at time 30 (\$Billions)	Average at time 30 (\$Billions)
Policy	57.4	38.6
65/35	62.0	40.6
LT Policy	60.4	40.9
Blended Scenario Model (50,25,25)	56.7	38.4
Steady Growth & Inflation	56.9	38.2
High Growth & Inflation	58.6	38.9
Low Growth & Inflation	56.0	39.3

TSERS Contribution Volatility Cost Curve

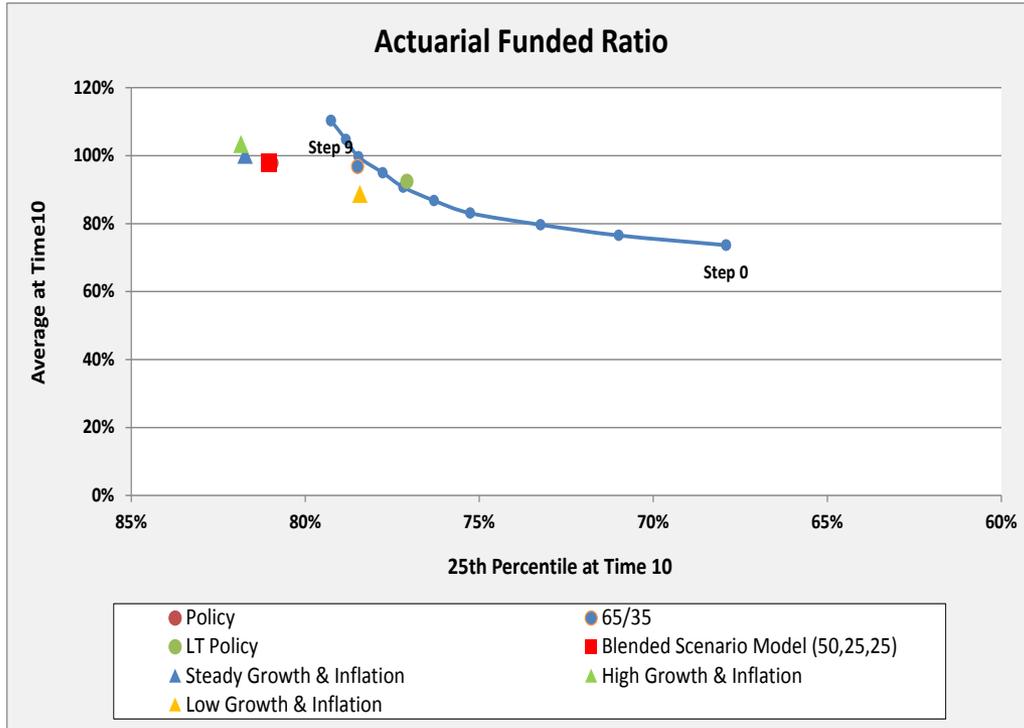
10 Year Horizon



	Frequency of Contribution Rate Increase > 3%	CTE 25 th Percentile at time 10 (\$Billions)
Policy	0.091	19.3
65/35	0.107	20.6
LT Policy	0.112	19.9
Blended Scenario Model (50,25,25)	0.088	19.0
Steady Growth & Inflation	0.089	19.2
High Growth & Inflation	0.088	19.8
Low Growth & Inflation	0.086	18.4

AVA Funded Ratio Curve

10 Year Horizon



	Average at time 10	25 th Percentile at Time 10
Policy	97.8%	81.0%
65/35	96.8%	78.5%
LT Policy	92.4%	77.1%
Blended Scenario Model (50,25,25)	97.8%	81.0%
Steady Growth & Inflation	100.2%	81.7%
High Growth & Inflation	103.4%	81.8%
Low Growth & Inflation	88.8%	78.4%

TSERS 75/25 Scenario Matrix

Scenario Counts	Scenario Count			10 – Year Compound Equity Return			10 – Year Compounded Inflation		
	10 Year CAGR Equity below 25th Percentile	10 Year CAGR Equity 25th - 75th Percentile	10 Year CAGR Equity above 75th Percentile	10 Year CAGR Equity below 25th Percentile	10 Year CAGR Equity 25th - 75th Percentile	10 Year CAGR Equity above 75th Percentile	10 Year CAGR Equity below 25th Percentile	10 Year CAGR Equity 25th - 75th Percentile	10 Year CAGR Equity above 75th Percentile
10 Year CAGR Inflation below 25th Percentile	67	127	55	-0.45%	7.05%	12.93%	0.53%	0.63%	0.65%
10 Year CAGR Inflation 25th - 75th Percentile	121	257	123	0.02%	6.88%	14.03%	2.01%	2.02%	2.16%
10 Year CAGR Inflation above 75th Percentile	61	117	71	0.22%	7.04%	13.66%	4.60%	4.32%	4.43%

Key:

Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)
Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation	

TSERS 75/25 Scenario Matrix – 10yr Average CAGR

	10 Year CAGR Equity below 25th Percentile				10 Year CAGR Equity between 25th and 75th Percentile				10 Year CAGR Equity above 75th Percentile			
10 Year CAGR Inflation below 25th Percentile	1.06%	0.69%	0.34%	1.11%	5.50%	5.60%	4.82%	5.35%	8.79%	9.34%	7.93%	8.66%
	1.08%	0.66%	1.56%		5.57%	5.67%	4.53%		9.10%	9.70%	6.69%	
10 Year CAGR Inflation between 25th and 75th Percentile	1.75%	1.08%	1.02%	1.91%	5.75%	5.45%	4.88%	5.79%	9.87%	10.04%	8.93%	9.75%
	1.91%	1.59%	2.17%		6.04%	6.25%	4.79%		10.25%	11.03%	7.42%	
10 Year CAGR Inflation above 75th Percentile	2.49%	1.21%	2.16%	2.78%	6.37%	5.54%	5.85%	6.54%	10.24%	9.84%	9.48%	10.34%
	2.81%	2.70%	2.73%		6.82%	7.24%	5.24%		10.86%	11.82%	7.79%	

= Best result

Key:

Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)
Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation	

TSERS 75/25 Scenario Matrix – 10yr Funded Ratio

	10 Year CAGR Equity below 25th Percentile				10 Year CAGR Equity between 25th and 75th Percentile				10 Year CAGR Equity above 75th Percentile			
10 Year CAGR Inflation below 25th Percentile	71.5%	70.0%	67.7%	71.7%	101.6%	102.9%	96.0%	100.3%	131.0%	137.5%	122.1%	129.8%
	71.7%	69.9%	73.5%		102.6%	104.2%	92.1%		135.0%	142.4%	108.8%	
10 Year CAGR Inflation between 25th and 75th Percentile	73.2%	70.1%	69.4%	74.0%	96.6%	94.6%	90.3%	97.0%	128.8%	131.7%	120.3%	127.6%
	74.2%	73.0%	74.5%		99.1%	101.4%	88.7%		133.2%	143.0%	105.3%	
10 Year CAGR Inflation above 75th Percentile	72.5%	67.2%	70.9%	73.8%	91.9%	87.9%	89.2%	92.7%	113.9%	112.4%	108.3%	114.7%
	74.0%	73.8%	73.0%		94.5%	97.6%	85.1%		119.3%	128.6%	96.7%	

= Best result

Key:

Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)
Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation	

TSERS 75/25 Scenario Matrix – 10yr Present Value of State Contributions (\$Billions)

	10 Year CAGR Equity below 25th Percentile				10 Year CAGR Equity between 25th and 75th Percentile				10 Year CAGR Equity above 75th Percentile			
10 Year CAGR Inflation below 25th Percentile	15.92	16.55	16.49	15.72	12.39	12.52	12.62	12.40	11.45	11.47	11.53	11.44
	15.85	16.49	14.83		12.41	12.54	12.42		11.43	11.43	11.58	
10 Year CAGR Inflation between 25th and 75th Percentile	17.00	18.05	17.73	16.73	13.46	13.79	13.99	13.44	12.27	12.34	12.48	12.27
	16.81	17.34	16.15		13.39	13.50	13.73		12.25	12.25	12.48	
10 Year CAGR Inflation above 75th Percentile	19.43	21.05	19.81	19.11	15.86	16.63	16.21	15.81	14.24	14.57	14.65	14.23
	19.18	19.56	18.71		15.75	15.77	16.36		14.17	14.13	15.00	

= Best result

Key:

Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)
Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation	

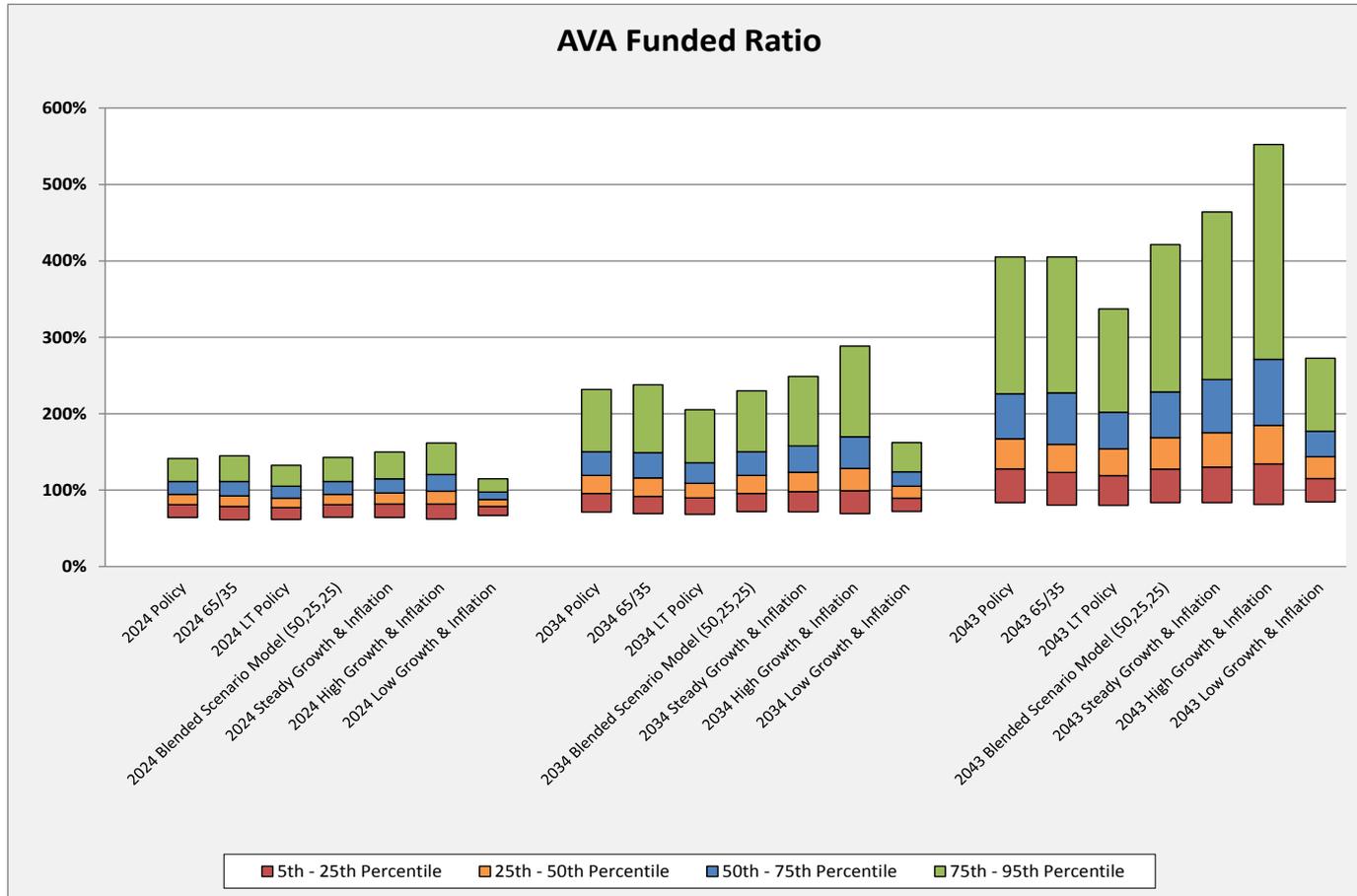
TSERS Performance Metrics Summary

	Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)	Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation
Expected Arithmetic Return - 10 yr	6.17%	5.94%	5.46%	6.19%	6.47%	6.80%	5.01%
Expected Volatility - 10 yr	9.61%	10.63%	9.91%	9.33%	9.82%	10.91%	7.12%
Expected Geometric Return - 10 yr	5.71%	5.38%	4.97%	5.75%	5.99%	6.21%	4.75%
Expected Return - 30 yr	7.53%	7.25%	7.00%	7.59%	7.81%	8.09%	6.65%
Expected Volatility - 30 yr	10.21%	11.23%	10.64%	9.98%	10.44%	11.54%	7.97%
Expected Geometric Return - 30 yr	7.01%	6.62%	6.43%	7.09%	7.27%	7.42%	6.34%
Equity Beta	0.577	0.651	0.580	0.546	0.583	0.652	0.372
Inflation Beta	0.66	0.45	0.80	0.69	0.71	0.77	0.61
Interest Rate Beta	-0.044	-0.042	-0.103	-0.059	-0.045	-0.019	-0.132
Average PV of Contributions at time 30	38.6	40.6	40.9	38.4	38.2	38.9	39.3
CTE 25th Percentile PV of Contributions at time 30	57.4	62.0	60.4	56.7	56.9	58.6	56.0
Frequency of Contribution Rate Increase > 3%	0.057	0.068	0.071	0.056	0.056	0.061	0.048
Probability Rolling 3 year CAGR < 0.00%	12.1%	14.85%	14.50%	11.86%	12.17%	13.86%	9.06%
Probability 30 year CAGR ≥ 7.25%	47%	41%	37%	48%	51%	53%	32%
AVA Funded Ratio 50th Percentile at time 30	167.3%	159.8%	153.9%	168.6%	175.1%	184.5%	143.6%
AVA Funded Ratio 5th Percentile at time 5	93.5%	92.3%	90.8%	94.3%	95.3%	96.4%	89.4%

Appendix

TSERS Funded Ratio – Range of Outcomes

Actuarial Value of Assets (AVA) Basis



AVA Funded Ratio as of 12/31/2014 was 95.6%

TSERS Funded Ratio – Range of Outcomes

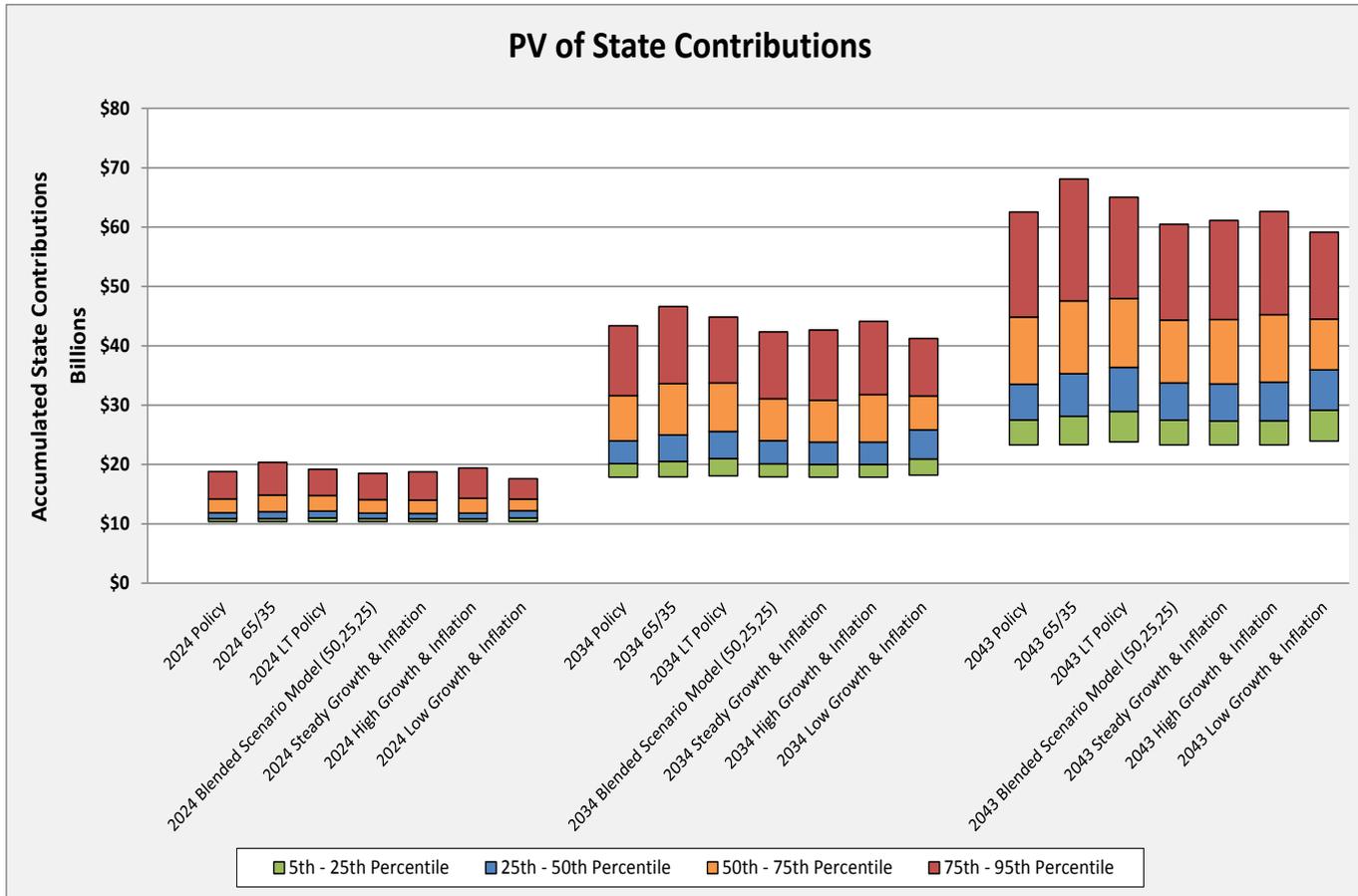
Actuarial Value of Assets (AVA) Basis

	2024 Policy	2024 65/35	2024 LT Policy	2024 Blended Scenario Model (50,25,25)	2024 Steady Growth & Inflation	2024 High Growth & Inflation	2024 Low Growth & Inflation
95th Percentile	141.3%	144.8%	132.6%	142.7%	149.9%	161.7%	114.8%
75th Percentile	111.4%	111.2%	105.1%	111.3%	114.9%	120.3%	97.4%
50th Percentile	94.29%	92.3%	89.3%	94.4%	96.2%	98.4%	87.6%
25th Percentile	81.0%	78.5%	77.1%	81.0%	81.7%	81.8%	78.4%
5th Percentile	64.0%	61.1%	61.5%	64.4%	64.2%	62.1%	66.9%

	2034 Policy	2034 65/35	2034 LT Policy	2034 Blended Scenario Model (50,25,25)	2034 Steady Growth & Inflation	2034 High Growth & Inflation	2034 Low Growth & Inflation
95th Percentile	231.8%	237.9%	205.3%	230.0%	248.9%	288.5%	162.1%
75th Percentile	150.1%	148.8%	135.7%	150.1%	157.6%	169.8%	124.0%
50th Percentile	119.0%	116.1%	109.0%	119.1%	123.4%	128.3%	105.0%
25th Percentile	95.5%	91.7%	89.6%	95.7%	98.0%	99.3%	89.5%
5th Percentile	71.1%	69.0%	68.2%	71.7%	71.4%	69.2%	72.1%

	2043 Policy	2043 65/35	2043 LT Policy	2043 Blended Scenario Model (50,25,25)	2043 Steady Growth & Inflation	2043 High Growth & Inflation	2043 Low Growth & Inflation
95th Percentile	405.1%	405.2%	337.1%	421.4%	464.0%	552.5%	272.5%
75th Percentile	226.2%	227.3%	202.0%	228.3%	244.7%	271.3%	176.9%
50th Percentile	167.3%	159.8%	153.9%	168.6%	175.1%	184.5%	143.6%
25th Percentile	127.8%	123.0%	118.9%	127.3%	130.1%	134.1%	115.1%
5th Percentile	83.5%	80.4%	79.9%	83.7%	83.7%	81.0%	84.4%

TSERS PV of State Contributions – Range of Outcomes



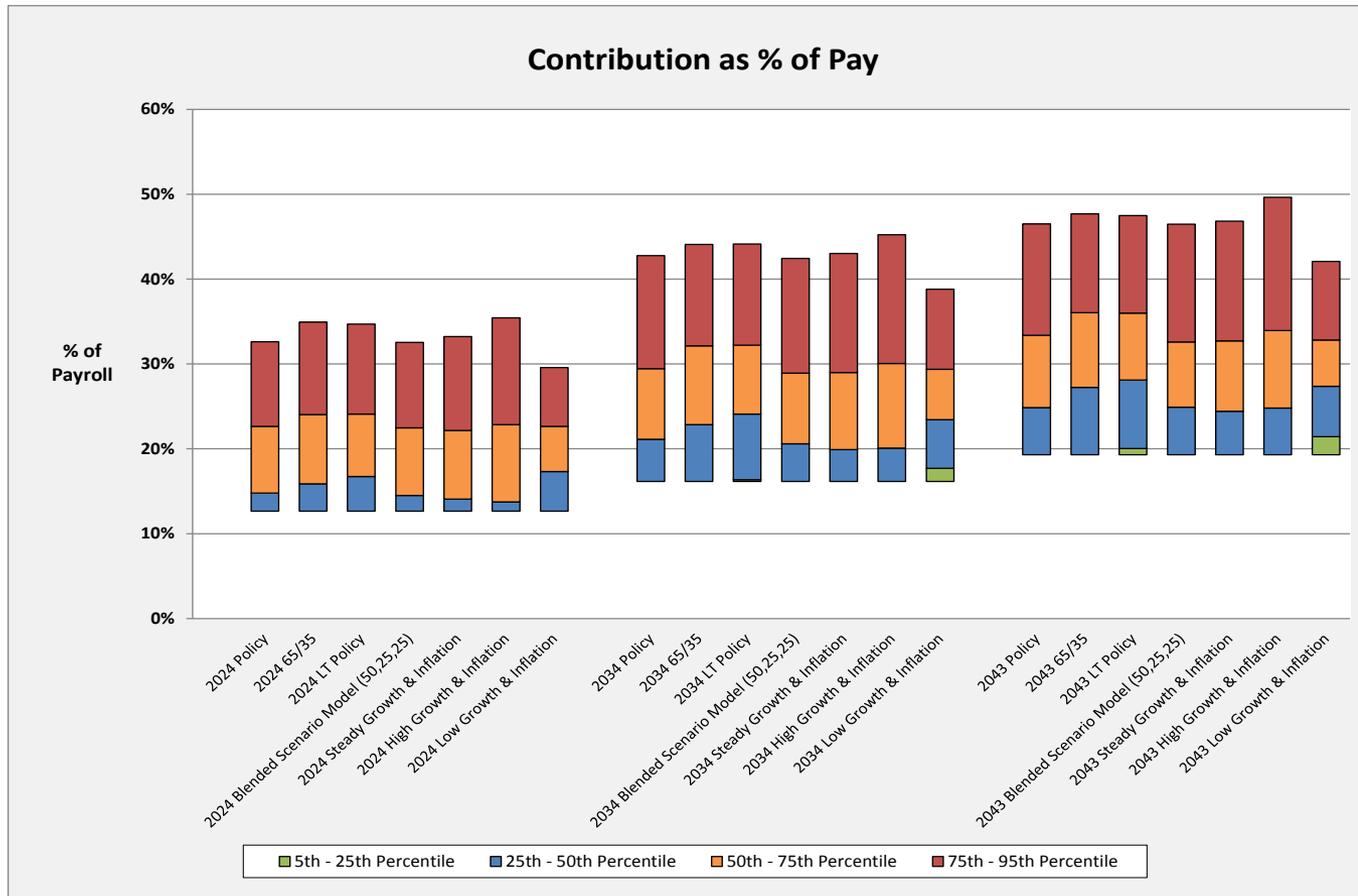
TSERS PV of State Contributions – Range of Outcomes

	2024 Policy	2024 65/35	2024 LT Policy	2024 Blended Scenario Model (50,25,25)	2024 Steady Growth & Inflation	2024 High Growth & Inflation	2024 Low Growth & Inflation
95th Percentile	18.8	20.4	19.2	18.5	18.7	19.4	17.6
75th Percentile	14.2	14.8	14.8	14.1	14.0	14.3	14.2
50th Percentile	11.9	12.1	12.1	11.8	11.8	11.8	12.2
25th Percentile	10.9	10.9	11.0	10.9	10.8	10.8	11.0
5th Percentile	10.4	10.4	10.4	10.4	10.4	10.4	10.4

	2034 Policy	2034 65/35	2034 LT Policy	2034 Blended Scenario Model (50,25,25)	2034 Steady Growth & Inflation	2034 High Growth & Inflation	2034 Low Growth & Inflation
95th Percentile	43.4	46.6	44.9	42.4	42.7	44.1	41.2
75th Percentile	31.6	33.6	33.7	31.1	30.8	31.8	31.6
50th Percentile	24.0	25.0	25.6	24.0	23.8	23.8	25.8
25th Percentile	20.1	20.5	21.0	20.1	20.0	20.0	20.9
5th Percentile	17.9	17.9	18.1	17.9	17.9	17.9	18.2

	2043 Policy	2043 65/35	2043 LT Policy	2043 Blended Scenario Model (50,25,25)	2043 Steady Growth & Inflation	2043 High Growth & Inflation	2043 Low Growth & Inflation
95th Percentile	62.5	68.1	65.0	60.5	61.1	62.6	59.2
75th Percentile	44.8	47.6	48.0	44.3	44.4	45.2	44.5
50th Percentile	33.5	35.3	36.4	33.8	33.6	33.9	35.9
25th Percentile	27.5	28.1	28.9	27.5	27.3	27.4	29.1
5th Percentile	23.3	23.3	23.8	23.3	23.3	23.3	23.9

TSERS Contributions as % of Pay - Range of Outcomes



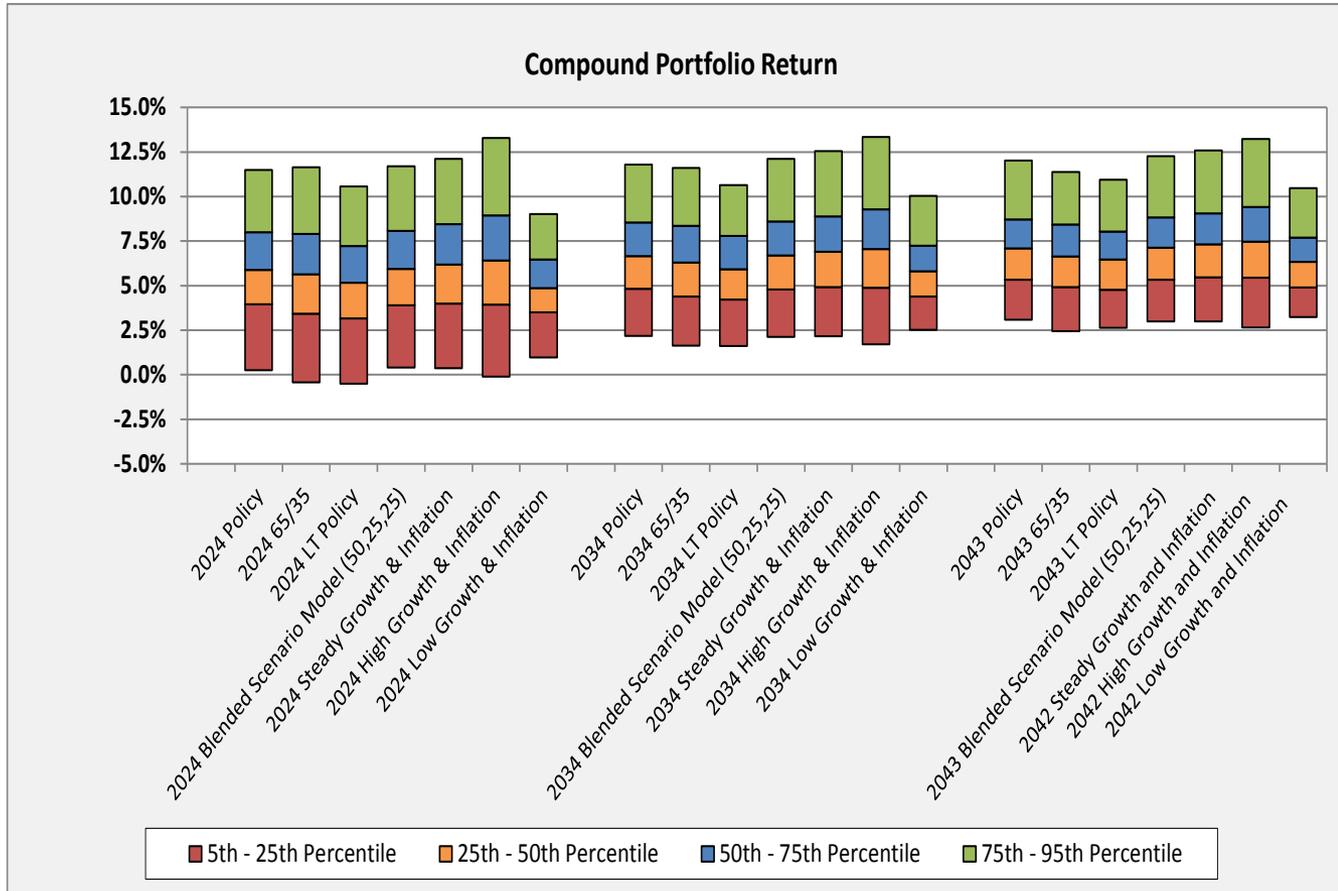
TSERS Contributions as % of Pay - Range of Outcomes

	2024		2024 LT	2024 Blended Scenario Model (50,25,25)	2024 Steady Growth & Inflation	2024 High Growth & Inflation	2024 Low Growth & Inflation
	2024 Policy	2024 65/35	Policy				
95th Percentile	32.6%	34.9%	34.7%	32.5%	33.2%	35.4%	29.6%
75th Percentile	22.7%	24.0%	24.1%	22.5%	22.2%	22.9%	22.7%
50th Percentile	14.8%	15.9%	16.7%	14.5%	14.1%	13.8%	17.3%
25th Percentile	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%
5th Percentile	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%

	2034		2034 LT	2034 Blended Scenario Model (50,25,25)	2034 Steady Growth & Inflation	2034 High Growth & Inflation	2034 Low Growth & Inflation
	2034 Policy	2034 65/35	Policy				
95th Percentile	42.8%	44.1%	44.1%	42.4%	43.0%	45.2%	38.8%
75th Percentile	29.4%	32.1%	32.2%	28.9%	29.0%	30.1%	29.4%
50th Percentile	21.1%	22.9%	24.1%	20.6%	19.9%	20.1%	23.5%
25th Percentile	16.2%	16.2%	16.4%	16.2%	16.2%	16.2%	17.7%
5th Percentile	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%

	2043		2043 LT	2043 Blended Scenario Model (50,25,25)	2043 Steady Growth & Inflation	2043 High Growth & Inflation	2043 Low Growth & Inflation
	2043 Policy	2043 65/35	Policy				
95th Percentile	46.5%	47.7%	47.5%	46.5%	46.8%	49.7%	42.1%
75th Percentile	33.4%	36.1%	36.0%	32.6%	32.7%	34.0%	32.8%
50th Percentile	24.9%	27.2%	28.1%	24.9%	24.4%	24.8%	27.4%
25th Percentile	19.3%	19.3%	20.0%	19.3%	19.3%	19.3%	21.4%
5th Percentile	19.3%	19.3%	19.3%	19.3%	19.3%	19.3%	19.3%

TSERS Compound Portfolio Return



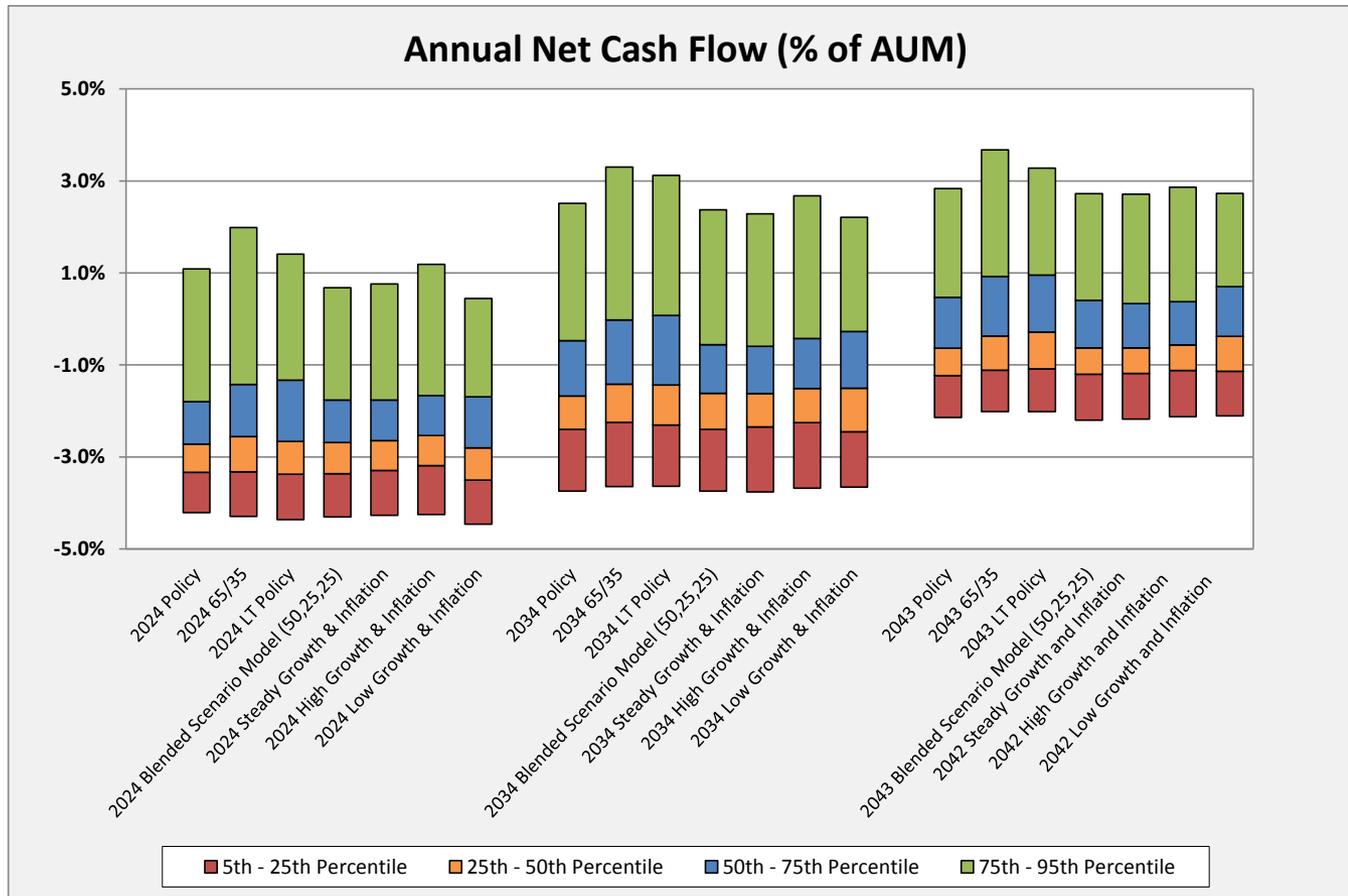
TSERS Compound Portfolio Return

	2024 Blended				2024 Steady	2024 High	2024 Low
	2024 Policy	2024 65/35	2024 LT Policy	Scenario Model (50,25,25)	Growth & Inflation	Growth & Inflation	Growth & Inflation
95th Percentile	11.5%	11.6%	10.6%	11.7%	12.1%	13.3%	9.0%
75th Percentile	8.0%	7.9%	7.2%	8.1%	8.4%	8.9%	6.5%
50th Percentile	5.9%	5.6%	5.2%	5.9%	6.2%	6.4%	4.9%
25th Percentile	4.0%	3.4%	3.2%	3.9%	4.0%	3.9%	3.5%
5th Percentile	0.2%	-0.4%	-0.5%	0.4%	0.4%	-0.1%	1.0%

	2034 Blended				2034 Steady	2034 High	2034 Low
	2034 Policy	2034 65/35	2034 LT Policy	Scenario Model (50,25,25)	Growth & Inflation	Growth & Inflation	Growth & Inflation
95th Percentile	11.8%	11.6%	10.6%	12.1%	12.5%	13.3%	10.0%
75th Percentile	8.5%	8.4%	7.8%	8.6%	8.9%	9.3%	7.3%
50th Percentile	6.7%	6.3%	5.9%	6.7%	6.9%	7.1%	5.8%
25th Percentile	4.8%	4.4%	4.2%	4.8%	4.9%	4.9%	4.4%
5th Percentile	2.2%	1.6%	1.6%	2.1%	2.2%	1.7%	2.5%

	2043 Blended				2043 Steady	2043 High	2043 Low
	2043 Policy	2043 65/35	2043 LT Policy	Scenario Model (50,25,25)	Growth & Inflation	Growth & Inflation	Growth & Inflation
95th Percentile	12.0%	11.4%	10.9%	12.3%	12.6%	13.2%	10.5%
75th Percentile	8.7%	8.4%	8.0%	8.8%	9.1%	9.4%	7.7%
50th Percentile	7.1%	6.6%	6.5%	7.1%	7.3%	7.5%	6.3%
25th Percentile	5.3%	4.9%	4.8%	5.3%	5.5%	5.4%	4.9%
5th Percentile	3.1%	2.4%	2.6%	3.0%	3.0%	2.7%	3.2%

TSERS Annual Net Cash Flow (% of AUM) – Range of Outcomes



TSERS Annual Net Cash Flow (% of AUM) – Range of Outcomes

	2024 Policy	2024 65/35	2024 LT Policy	2024 Blended Scenario Model (50,25,25)	2024 Steady Growth & Inflation	2024 High Growth & Inflation	2024 Low Growth & Inflation
95th Percentile	1.1%	2.0%	1.4%	0.7%	0.8%	1.2%	0.4%
75th Percentile	-1.8%	-1.4%	-1.3%	-1.8%	-1.8%	-1.7%	-1.7%
50th Percentile	-2.7%	-2.6%	-2.7%	-2.7%	-2.6%	-2.5%	-2.8%
25th Percentile	-3.3%	-3.3%	-3.4%	-3.4%	-3.3%	-3.2%	-3.5%
5th Percentile	-4.2%	-4.3%	-4.4%	-4.3%	-4.3%	-4.3%	-4.5%

	2034 Policy	2034 65/35	2034 LT Policy	2034 Blended Scenario Model (50,25,25)	2034 Steady Growth & Inflation	2034 High Growth & Inflation	2034 Low Growth & Inflation
95th Percentile	2.5%	3.3%	3.1%	2.4%	2.3%	2.7%	2.2%
75th Percentile	-0.5%	0.0%	0.1%	-0.6%	-0.6%	-0.4%	-0.3%
50th Percentile	-1.7%	-1.4%	-1.4%	-1.6%	-1.6%	-1.5%	-1.5%
25th Percentile	-2.4%	-2.3%	-2.3%	-2.4%	-2.3%	-2.3%	-2.5%
5th Percentile	-3.7%	-3.6%	-3.6%	-3.7%	-3.8%	-3.7%	-3.7%

	2043 Policy	2043 65/35	2043 LT Policy	2043 Blended Scenario Model (50,25,25)	2043 Steady Growth & Inflation	2043 High Growth & Inflation	2043 Low Growth & Inflation
95th Percentile	2.8%	3.7%	3.3%	2.7%	2.7%	2.9%	2.7%
75th Percentile	0.5%	0.9%	1.0%	0.4%	0.3%	0.4%	0.7%
50th Percentile	-0.6%	-0.4%	-0.3%	-0.6%	-0.6%	-0.6%	-0.4%
25th Percentile	-1.2%	-1.1%	-1.1%	-1.2%	-1.2%	-1.1%	-1.1%
5th Percentile	-2.1%	-2.0%	-2.0%	-2.2%	-2.2%	-2.1%	-2.1%

TSERS 90/10 Scenario Matrix

Scenario Counts	Scenario Count			10 – Year Compound Equity Return			10 – Year Compounded Inflation		
	10 Year CAGR Equity below 10th Percentile	10 Year CAGR Equity 10th - 90th Percentile	10 Year CAGR Equity above 90th Percentile	10 Year CAGR Equity below 10th Percentile	10 Year CAGR Equity 10th - 90th Percentile	10 Year CAGR Equity above 90th Percentile	10 Year CAGR Equity below 10th Percentile	10 Year CAGR Equity 10th - 90th Percentile	10 Year CAGR Equity above 90th Percentile
10 Year CAGR Inflation below 10th Percentile	16	78	5	-4.07%	6.92%	16.52%	0.13%	0.23%	0.22%
10 Year CAGR Inflation 10th - 90th Percentile	73	647	81	-2.72%	6.93%	16.41%	2.10%	2.11%	2.28%
10 Year CAGR Inflation above 90th Percentile	10	76	13	-2.98%	6.87%	16.46%	5.24%	5.59%	5.97%

Key:

Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)
Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation	

TSERS 90/10 Scenario Matrix – 10yr Average CAGR

	10 Year CAGR Equity below 10th Percentile				10 Year CAGR Equity between 10th and 90th Percentile				10 Year CAGR Equity above 90th Percentile			
10 Year CAGR Inflation below 10th Percentile	-1.25%	-1.60%	-1.82%	-1.11%	5.32%	5.51%	4.63%	5.18%	10.85%	11.88%	10.17%	10.54%
	-1.29%	-1.99%	0.03%		5.39%	5.47%	4.40%		11.06%	11.84%	8.14%	
10 Year CAGR Inflation between 10th and 90th Percentile	0.15%	-0.65%	-0.47%	0.37%	5.77%	5.48%	4.96%	5.79%	11.27%	11.60%	10.30%	11.20%
	0.26%	-0.27%	1.14%		6.04%	6.26%	4.77%		11.78%	12.80%	8.39%	
10 Year CAGR Inflation above 90th Percentile	0.86%	-0.77%	0.86%	1.16%	6.66%	5.42%	6.25%	6.96%	12.29%	11.74%	12.04%	12.23%
	1.07%	0.72%	1.70%		7.25%	7.79%	5.49%		12.86%	14.01%	9.13%	

 = Best result

Key:

Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)
Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation	

TSERS 90/10 Scenario Matrix – 10yr Funded Ratio

	10 Year CAGR Equity below 10th Percentile				10 Year CAGR Equity between 10th and 90th Percentile				10 Year CAGR Equity above 90th Percentile			
10 Year CAGR Inflation below 10th Percentile	61.3%	59.8%	58.6%	62.0%	103.4%	105.5%	97.5%	102.3%	162.2%	179.0%	154.4%	156.7%
	61.4%	58.5%	67.2%		104.7%	106.6%	93.5%		164.2%	176.0%	125.8%	
10 Year CAGR Inflation between 10th and 90th Percentile	64.8%	61.9%	62.2%	65.8%	96.9%	95.6%	91.3%	97.0%	139.7%	144.5%	129.9%	138.9%
	65.5%	63.4%	68.8%		99.2%	101.7%	88.7%		146.1%	159.6%	110.9%	
10 Year CAGR Inflation above 90th Percentile	65.0%	58.6%	64.3%	66.7%	89.8%	84.1%	87.7%	91.1%	122.0%	120.7%	117.4%	121.5%
	66.6%	65.6%	68.1%		93.0%	96.7%	83.3%		127.6%	140.0%	98.7%	

= Best result

Key:

Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)
Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation	

TSERS 90/10 Scenario Matrix – 10yr Present Value of State Contributions (\$Billions)

	10 Year CAGR Equity below 10th Percentile				10 Year CAGR Equity between 10th and 90th Percentile				10 Year CAGR Equity above 90th Percentile			
10 Year CAGR Inflation below 10th Percentile	17.55	18.11	18.00	17.22	12.54	12.60	12.71	12.57	11.16	11.16	11.16	11.16
	17.47	18.25	15.75		12.59	12.80	12.42		11.16	11.17	11.16	
10 Year CAGR Inflation between 10th and 90th Percentile	18.27	19.42	18.99	17.92	13.96	14.41	14.43	13.90	12.29	12.36	12.46	12.27
	18.09	18.78	16.96		13.88	14.01	14.08		12.25	12.24	12.49	
10 Year CAGR Inflation above 90th Percentile	22.09	23.76	21.87	21.99	16.64	17.67	16.94	16.55	14.37	14.70	14.69	14.35
	22.22	22.86	20.78		16.48	16.49	17.16		14.30	14.28	15.01	

= Best result

Key:

Policy	65/35	LT Policy	Blended Scenario Model (50,25,25)
Steady Growth & Inflation	High Growth & Inflation	Low Growth & Inflation	

Key Assumptions – Treasury Key Rates

Forecast Year	Average Key Treasury Rates										
	0.25	1.00	2.00	3.00	5.00	7.00	10.00	15.00	20.00	25.00	30.00
0	0.04%	0.59%	0.96%	1.16%	1.43%	1.63%	1.90%	2.23%	2.57%	2.78%	2.98%
1	0.44%	0.81%	1.14%	1.38%	1.69%	1.89%	2.10%	2.35%	2.53%	2.66%	2.76%
2	0.77%	1.14%	1.48%	1.72%	2.04%	2.24%	2.45%	2.68%	2.83%	2.94%	3.02%
3	1.08%	1.45%	1.80%	2.04%	2.36%	2.56%	2.77%	2.99%	3.13%	3.22%	3.29%
4	1.38%	1.75%	2.10%	2.34%	2.66%	2.86%	3.07%	3.28%	3.41%	3.49%	3.54%
5	1.72%	2.09%	2.44%	2.69%	3.01%	3.21%	3.41%	3.60%	3.72%	3.78%	3.82%
6	2.04%	2.41%	2.76%	3.01%	3.33%	3.53%	3.72%	3.91%	4.01%	4.06%	4.09%
7	2.18%	2.56%	2.91%	3.16%	3.49%	3.69%	3.89%	4.07%	4.17%	4.22%	4.24%
8	2.37%	2.75%	3.11%	3.36%	3.69%	3.90%	4.09%	4.28%	4.37%	4.41%	4.42%
9	2.49%	2.87%	3.23%	3.49%	3.82%	4.03%	4.23%	4.41%	4.50%	4.54%	4.55%
10	2.63%	3.01%	3.38%	3.64%	3.97%	4.18%	4.39%	4.57%	4.65%	4.69%	4.69%
11	2.80%	3.19%	3.56%	3.82%	4.15%	4.37%	4.57%	4.75%	4.82%	4.85%	4.85%
12	2.94%	3.33%	3.70%	3.96%	4.31%	4.52%	4.72%	4.90%	4.98%	5.00%	5.00%
13	3.09%	3.48%	3.85%	4.12%	4.46%	4.68%	4.88%	5.06%	5.13%	5.15%	5.14%
14	3.20%	3.59%	3.96%	4.23%	4.58%	4.79%	5.00%	5.17%	5.24%	5.26%	5.25%
15	3.27%	3.67%	4.04%	4.31%	4.66%	4.87%	5.08%	5.25%	5.32%	5.33%	5.32%
16	3.28%	3.67%	4.05%	4.32%	4.68%	4.90%	5.11%	5.29%	5.36%	5.37%	5.36%
17	3.23%	3.63%	4.01%	4.29%	4.65%	4.88%	5.09%	5.28%	5.35%	5.37%	5.36%
18	3.32%	3.72%	4.10%	4.37%	4.74%	4.96%	5.18%	5.36%	5.43%	5.44%	5.43%
19	3.44%	3.84%	4.23%	4.51%	4.87%	5.10%	5.32%	5.50%	5.56%	5.57%	5.56%
20	3.40%	3.81%	4.20%	4.48%	4.85%	5.08%	5.31%	5.49%	5.56%	5.57%	5.55%
21	3.44%	3.85%	4.24%	4.52%	4.89%	5.13%	5.35%	5.54%	5.60%	5.62%	5.60%
22	3.49%	3.90%	4.29%	4.57%	4.95%	5.19%	5.41%	5.60%	5.67%	5.68%	5.66%
23	3.53%	3.94%	4.34%	4.62%	5.00%	5.25%	5.47%	5.66%	5.73%	5.74%	5.72%
24	3.53%	3.94%	4.34%	4.62%	5.01%	5.25%	5.48%	5.67%	5.74%	5.75%	5.74%
25	3.53%	3.94%	4.34%	4.62%	5.01%	5.25%	5.48%	5.67%	5.74%	5.75%	5.74%
26	3.56%	3.97%	4.37%	4.66%	5.04%	5.29%	5.52%	5.71%	5.78%	5.79%	5.78%
27	3.56%	3.97%	4.37%	4.66%	5.05%	5.30%	5.54%	5.73%	5.80%	5.81%	5.80%
28	3.57%	3.98%	4.38%	4.68%	5.07%	5.32%	5.56%	5.76%	5.83%	5.84%	5.82%
29	3.52%	3.94%	4.34%	4.64%	5.03%	5.29%	5.53%	5.73%	5.81%	5.82%	5.81%
30	3.52%	3.94%	4.35%	4.64%	5.04%	5.30%	5.54%	5.74%	5.82%	5.83%	5.82%

Naïve Investment Strategies

TSRERS Asset Class	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9
Global Equity	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
Fixed Income	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%
Inflation*	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

* Combination of Commodities and TIPS with Commodities increasing linearly from 0% to 100% of Inflation

Capital Market Assumptions

Return and Risk

	3 Year			5 Year			10 Year		
	Arithmetic Expected Return	Geometric Expected Return	Standard Deviation	Arithmetic Expected Return	Geometric Expected Return	Standard Deviation	Arithmetic Expected Return	Geometric Expected Return	Standard Deviation
Long Only Public Equity	7.06%	6.43%	14.20%	7.52%	6.64%	15.24%	7.96%	6.89%	15.93%
Hedged Equity	5.32%	5.22%	5.68%	5.51%	5.37%	6.10%	5.68%	5.51%	6.37%
Private Equity	10.26%	8.12%	25.10%	11.07%	8.18%	26.75%	12.24%	8.57%	28.39%
Non-Core Real Estate	8.21%	7.58%	17.27%	7.12%	6.14%	18.12%	7.27%	5.97%	19.05%
Distressed	7.89%	7.20%	14.85%	8.33%	7.48%	15.03%	8.50%	7.55%	15.02%
High Yield	6.10%	5.80%	9.72%	6.54%	6.16%	9.83%	7.48%	7.06%	10.01%
Government	1.40%	1.16%	7.91%	0.98%	0.66%	8.44%	1.88%	1.41%	9.99%
Corporate	1.66%	1.51%	6.50%	1.82%	1.61%	6.96%	2.99%	2.69%	8.07%
Mortgage	0.40%	0.39%	2.19%	0.68%	0.64%	3.04%	1.73%	1.64%	4.59%
Cash	0.90%	0.90%	0.97%	1.32%	1.32%	1.39%	2.12%	2.11%	2.12%
TIPS	2.51%	2.45%	3.92%	2.83%	2.77%	3.99%	3.64%	3.56%	4.25%
Publicly Traded Natural Resources	2.16%	0.58%	23.71%	2.03%	0.11%	24.33%	2.67%	0.34%	25.45%
Private Natural Resources/Real Assets	6.60%	5.61%	17.94%	7.01%	5.70%	18.76%	7.69%	6.10%	19.64%
Private Equity Core Real Estate	6.46%	6.31%	8.48%	5.92%	5.69%	8.90%	6.00%	5.69%	9.36%
Public Equity Core Real Estate	4.54%	3.49%	18.46%	5.09%	3.76%	18.77%	5.77%	4.19%	19.37%
Multi-Strategy	5.55%	5.32%	8.39%	5.83%	5.55%	8.62%	6.01%	5.69%	8.69%

Capital Market Assumptions

Return and Risk

	15 Year			20 Year			30 Year		
	Arithmetic Expected Return	Geometric Expected Return	Standard Deviation	Arithmetic Expected Return	Geometric Expected Return	Standard Deviation	Arithmetic Expected Return	Geometric Expected Return	Standard Deviation
Long Only Public Equity	8.28%	7.12%	16.30%	8.46%	7.27%	16.44%	8.72%	7.47%	16.63%
Hedged Equity	5.81%	5.63%	6.52%	5.89%	5.69%	6.58%	5.99%	5.79%	6.65%
Private Equity	13.00%	9.05%	29.01%	13.51%	9.45%	29.03%	14.15%	9.92%	29.34%
Non-Core Real Estate	7.78%	6.32%	19.56%	7.98%	6.41%	19.96%	8.70%	7.00%	20.41%
Distressed	8.73%	7.75%	15.00%	8.92%	7.92%	15.08%	9.11%	8.07%	15.12%
High Yield	8.15%	7.70%	10.13%	8.60%	8.15%	10.24%	9.28%	8.81%	10.41%
Government	2.73%	2.15%	11.10%	3.51%	2.86%	11.85%	4.52%	3.79%	12.66%
Corporate	3.86%	3.50%	8.76%	4.59%	4.19%	9.24%	5.49%	5.06%	9.69%
Mortgage	2.51%	2.38%	5.43%	3.12%	2.97%	5.90%	3.86%	3.69%	6.18%
Cash	2.65%	2.63%	2.57%	3.01%	2.98%	2.86%	3.50%	3.47%	3.17%
TIPS	4.21%	4.13%	4.49%	4.62%	4.54%	4.67%	5.17%	5.08%	4.89%
Publicly Traded Natural Resources	3.59%	1.07%	25.79%	4.10%	1.49%	25.88%	5.51%	2.69%	26.67%
Private Natural Resources/Real Assets	8.16%	6.46%	19.99%	8.46%	6.70%	20.12%	9.04%	7.19%	20.45%
Private Equity Core Real Estate	6.25%	5.90%	9.61%	6.35%	5.97%	9.80%	6.70%	6.29%	10.02%
Public Equity Core Real Estate	6.34%	4.64%	19.79%	6.70%	4.97%	19.83%	7.08%	5.31%	19.90%
Multi-Strategy	6.19%	5.86%	8.73%	6.33%	5.99%	8.80%	6.48%	6.12%	8.85%

Capital Market Assumptions

10 Year Correlations

	Long Only Public Equity	Hedged Equity	Private Equity	Non-Core Real Estate	Distressed	High Yield	Government	Corporate	Mortgage	Cash	TIPS	Publicly Traded Natural Resources	Private Natural Resources/ Real Assets	Private Equity Core Real Estate	Public Equity Core Real Estate	Multi- Strategy
Long Only Public Equity	1.000															
Hedged Equity	1.000	1.000														
Private Equity	0.845	0.845	1.000													
Non-Core Real Estate	0.144	0.144	0.122	1.000												
Distressed	0.370	0.370	0.329	0.059	1.000											
High Yield	0.642	0.642	0.609	0.107	0.260	1.000										
Government	-0.064	-0.064	0.005	0.027	-0.008	0.355	1.000									
Corporate	0.101	0.101	0.157	0.045	0.058	0.515	0.959	1.000								
Mortgage	-0.022	-0.022	0.040	0.066	0.006	0.364	0.895	0.885	1.000							
Cash	0.124	0.124	0.131	0.187	0.043	0.184	0.143	0.213	0.421	1.000						
TIPS	0.030	0.030	0.059	0.116	0.020	0.187	0.354	0.385	0.443	0.436	1.000					
Publicly Traded Natural Resources	0.211	0.211	0.213	0.197	0.103	0.158	-0.010	0.030	0.008	0.068	0.235	1.000				
Private Natural Resources/Real Assets	0.829	0.829	0.720	0.160	0.302	0.538	0.003	0.134	0.034	0.115	0.111	0.447	1.000			
Private Equity Core Real Estate	0.144	0.144	0.122	1.000	0.059	0.107	0.027	0.045	0.066	0.187	0.116	0.197	0.160	1.000		
Public Equity Core Real Estate	0.615	0.615	0.644	0.090	0.238	0.441	0.005	0.114	0.037	0.106	0.041	0.140	0.630	0.090	1.000	
Multi-Strategy	0.564	0.564	0.502	0.088	0.974	0.399	-0.005	0.095	0.017	0.072	0.033	0.145	0.457	0.088	0.364	1.000

Capital Market Assumptions

20 Year Correlations

	Long Only Public Equity	Hedged Equity	Private Equity	Non-Core Real Estate	Distressed	High Yield	Government	Corporate	Mortgage	Cash	TIPS	Publicly Traded Natural Resources	Private Natural Resources/Real Assets	Private Equity Core Real Estate	Public Equity Core Real Estate	Multi-Strategy
Long Only Public Equity	1.000															
Hedged Equity	1.000	1.000														
Private Equity	0.846	0.846	1.000													
Non-Core Real Estate	0.158	0.158	0.140	1.000												
Distressed	0.385	0.385	0.344	0.067	1.000											
High Yield	0.623	0.623	0.599	0.140	0.270	1.000										
Government	-0.061	-0.061	0.018	0.063	0.011	0.424	1.000									
Corporate	0.082	0.082	0.150	0.088	0.068	0.556	0.970	1.000								
Mortgage	-0.016	-0.016	0.060	0.120	0.027	0.439	0.923	0.915	1.000							
Cash	0.146	0.146	0.165	0.267	0.065	0.266	0.256	0.320	0.505	1.000						
TIPS	0.051	0.051	0.089	0.183	0.037	0.265	0.427	0.463	0.541	0.580	1.000					
Publicly Traded Natural Resources	0.214	0.214	0.214	0.211	0.097	0.161	0.001	0.038	0.036	0.121	0.251	1.000				
Private Natural Resources/Real Assets	0.833	0.833	0.724	0.182	0.311	0.534	0.015	0.130	0.054	0.152	0.133	0.450	1.000			
Private Equity Core Real Estate	0.158	0.158	0.140	1.000	0.067	0.140	0.063	0.088	0.120	0.267	0.183	0.211	0.182	1.000		
Public Equity Core Real Estate	0.624	0.624	0.652	0.111	0.247	0.440	0.023	0.119	0.061	0.150	0.080	0.152	0.637	0.111	1.000	
Multi-Strategy	0.580	0.580	0.518	0.100	0.973	0.406	0.016	0.103	0.041	0.100	0.057	0.141	0.469	0.100	0.376	1.000

Capital Market Assumptions

30 Year Correlations

	Long Only Public Equity	Hedged Equity	Private Equity	Non-Core Real Estate	Distressed	High Yield	Government	Corporate	Mortgage	Cash	TIPS	Publicly Traded Natural Resources	Private Natural Resources/Real Assets	Private Equity Core Real Estate	Public Equity Core Real Estate	Multi-Strategy
Long Only Public Equity	1.000															
Hedged Equity	1.000	1.000														
Private Equity	0.848	0.848	1.000													
Non-Core Real Estate	0.161	0.161	0.149	1.000												
Distressed	0.394	0.394	0.356	0.071	1.000											
High Yield	0.618	0.618	0.599	0.156	0.278	1.000										
Government	-0.057	-0.057	0.025	0.080	0.019	0.445	1.000									
Corporate	0.080	0.080	0.151	0.109	0.076	0.569	0.973	1.000								
Mortgage	-0.005	-0.005	0.073	0.151	0.039	0.464	0.921	0.918	1.000							
Cash	0.157	0.157	0.180	0.303	0.076	0.297	0.280	0.347	0.537	1.000						
TIPS	0.060	0.060	0.102	0.212	0.045	0.294	0.444	0.482	0.571	0.624	1.000					
Publicly Traded Natural Resources	0.220	0.220	0.219	0.224	0.094	0.167	0.004	0.044	0.056	0.155	0.270	1.000				
Private Natural Resources/Real Assets	0.835	0.835	0.729	0.186	0.321	0.533	0.019	0.131	0.066	0.166	0.142	0.455	1.000			
Private Equity Core Real Estate	0.161	0.161	0.149	1.000	0.071	0.156	0.080	0.109	0.151	0.303	0.212	0.224	0.186	1.000		
Public Equity Core Real Estate	0.627	0.627	0.656	0.117	0.254	0.441	0.027	0.120	0.070	0.158	0.087	0.156	0.639	0.117	1.000	
Multi-Strategy	0.588	0.588	0.529	0.105	0.973	0.413	0.025	0.110	0.054	0.113	0.066	0.139	0.479	0.105	0.384	1.000

TSERS Key Actuarial Methods and Assumptions

Item	Methodology
Assumed Portfolio Return	7.25%
Actuarial Funding Method	<ul style="list-style-type: none"> • Actuarial cost method: Individual entry age normal cost method • Asset smoothing: Asset returns in excess of or less than the expected return on market value of assets will be reflected in the actuarial value of assets over a five-year period.
Funding Policy	<ul style="list-style-type: none"> • Two components, stated as a percentage of payroll <ul style="list-style-type: none"> – Normal cost: uniform percentage of pay from new entrant to termination or retirement – Accrued liability: amortization of unfunded actuarial accrued liability over 12 years • Funding policy modeled incorporates Employer Contribution Rate Stabilization Policy
Future Population	Level future population
Mortality	Mortality rates with improvements using MP-2015

TSERS Key Actuarial Methods and Assumptions

Item	Methodology
Wages Increases	<ul style="list-style-type: none"> • General and wage inflation: 3% • Productivity Increase: 0.5% • Representative assumed rates of salary increase <ul style="list-style-type: none"> – Classroom teachers: 3.50%-7.55% – General employees: 3.50%-5.50% – Law enforcement: 3.50%-8.10% – Other education: 3.50%-7.00%
General Benefit Provisions	Benefit provisions currently in effect
COLA	<ul style="list-style-type: none"> • COLA is a significant risk factor that any investment strategy needs to recognize • The incidence of future COLA grants is unknown and recent decisions with respect to COLA grants may not be the best indicator of long term practices • Ignoring a COLA in modeling can significantly understate liabilities and contribution requirements • Modeling Approach for ALM: <ul style="list-style-type: none"> – Assume No COLA granted in first five years of forecast – After five years, COLA granted annually to the extent that the COLA could be fully funded from the gain on the Actuarial Value of Assets, but limited to the increase in CPI-U for the year

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